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Journey to Armageddon 68

For *Armageddon*, about roughneck oil drillers sent on a heroic mission into space to save earth from a killer asteroid, director Michael Bay and producer Jerry Bruckheimer needed near-nonstop visual effects to support the action. To meet the demand, the production formed an in-house effects unit, Vfx, overseen by visual effects supervisor Pat McClung, and engaged Dream Quest Images, under fellow supervisor Richard Hoover. Also making sizable contributions were Blue Sky | VIFX, Digital Domain, Cinesite and Computer Film Company. *Article by Mark Cotta Vaz.*

A Small Soldiers Story 96

For the high-concept DreamWorks project *Small Soldiers*, centering on toy action figures implanted with high-tech military computer chips that allow them to take on a life of their own, director Joe Dante worked closely with Stan Winston Studio, which designed the Commando Elite and Gorgonite characters and then built them in puppet form for use on set, and Industrial Light & Magic, which duplicated the combative toys in digital form and computer-animated them for scenes requiring complex action. *Article by Jody Duncan.*

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COVER – Chip Hazard brandishes his weapon in *Small Soldiers*.

FROM THE EARTH TO THE MOON SHOOTING THE MOON

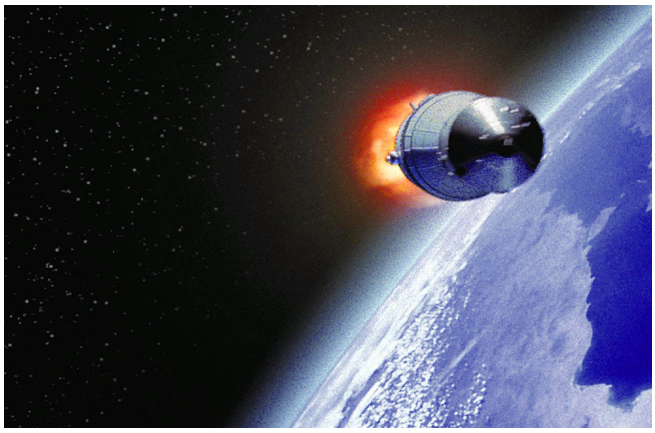
ARTICLE BY KEVIN H. MARTIN

In the wake of *Apollo 11*'s historic 1969 moon landing, a special Space Task Force was formed to set up a series of logical and necessary next steps for America's National Aeronautics and Space Ad ministration. After completing its initial series of lunar explorations with Apollo 20, NASA would develop and launch the world's first fully-reusable space shuttle and orbit a permanently manned space station by 1975. The U.S. space agency would then take aim at even loftier targets, first with the establishment of a moonbase, and then by launch ing human explorers on an expedition to Mars in 1981.

While this sounds like a possible backstory for 2001: A *Space Odyssey*, it was, for its time, a legitimate projection of NASA objectives. With nearly three decades of hindsight, this forecast seems hilariously optimistic, reflecting the same can-do notion of progress that had Popular Science and other magazines of its ilk predicting we soon would be flying to work via rocket belts. In reality, man has forsaken the moon, restricting his interplanetary excursions to the occasional unmanned probe. While these craft have increased our knowledge of the planets, they do not evoke the sense of romance and accomplishment inspired by the manned space program. That drama, which unfolded in the turbulent decade between 1961 and 1972, irrevocably altered the perceptions of those who gazed up into the night sky.

Among those stargazers was Tom Hanks. As an adult, the actor read Andrew Chaikin's history of the Apollo program, A Man on the Moon, while preparing for his role as astronaut Jim Lovell in *Apollo 13*. Excited by the way in which the book captured the true scope of the Apollo project, Hanks became enamored with the notion of depicting Apollo's glory days on film; but even in his enthusiasm, he realized that such a vast subject could not be condensed into the limited time span of a single feature film, and would require a longer form, such as a miniseries. It soon became clear to Hanks that he would need to return to television, a medium he had abandoned more than a decade earlier.

In partnership with Imagine Entertainment, Hanks' Clavius Base company–named for a lunar locale in 2001, one of his favorite films–approached Home Box Office with the idea of producing a television series that would tell the story of the Apollo program from its big-bang inception to its whimper of a close. The Hanks/HBO collaboration, dubbed *From the Earth to the Moon* in a nod to Jules Verne's first space travel novel, was to consist of a dozen fifty-minute mini-movies. Hanks would contribute his services as actor, writer and director, while also drawing on the talents of other top-rate writers and directors. The



Feature-quality effects on a television budget was the manifesto for Ernest D. Farino, visual effects supervisor for the HBO miniseries, From the Earth to the Moon. A

series would span the dawn of manned spaceflight in 1961–beginning with news of Russian cosmonaut Yuri Gagarin's first orbital flight –to NASA projects Mercury, Gemini and Apollo, the latter culminating in a near-perfect series of manned lunar landings and explorations.

miniature Saturn rocket was composited with digital enhancements into a NASA still photo background by AI Effects.

In the last decade, the cable giant had dabbled in effects-oriented fare ranging from the fantastic–Cast a Deadly Spell, Witch Hunt and *Attack of the 50 Foot Woman*–to the chilling, such as *By Dawn's Early Light*. But none of those previous endeavors had required the variety of effects techniques and vendors that Hanks' dream project would demand. HBO director of production Bruce R. Richmond selected Ernest Farino to head up the effects effort. Farino had supervised the visual effects for Cast a Deadly Spell five years earlier and was just finishing up a six-month stay at Sony Pictures Image works, setting up *Starship Troopers*. "I'd directed four episodes of the Monsters TV series for Tony To, who became co-executive producer with Tom Hanks on this show," Farino noted. "When Tony called me about *From the Earth to the Moon*, I became excited, thinking he meant the Verne story. Learning it was a history of the American space program got me even more enthused."

That enthusiasm would spread to the various vendors who contributed effects for the production. AI Effects and Area 51 created digital rockets and space capsules, while Hunter/Gratzner Industries and Vision Crew Unlimited fabricated spacecraft and rockets in miniature. Synthetic lunar and deep space backgrounds would be provided by Pacific Ocean Post, Todd AO/Hollywood Digital and Pacific Title/ Mirage Studio, with additional animation by THDX/ Title House.

The liftoff of the Redstone rocket carrying Mercury astronaut Alan B. Shepherd on the first U.S. manned suborbital flight was computer generated in its entirety by Area 51.

Farino began by forming an in-house visual effects department, bringing *Apollo 13* storyboard artist Eric Ramsay aboard to design shots. From the beginning, Hanks and Farino agreed on the look for spaceflight scenes. "Tom is a big fan of 2001," said Farino, "and since I favored having a physical object to light, we locked into the idea of shooting miniatures. We didn't copy 2001, but I did want to recapture that film's sense of poetry in movement. Tom's single, hard-and-fast rule was to never duplicate stock footage. He wanted authentic-looking, naturalistic imagery, but demanded a cinematic look as well; and models seemed to be the best way to achieve that."

Initially, Farino intended to do all of the space flight shots via physical models, fearing that CG effects would clash visually with the Sixties-style technology the show would be portraying. But budgetary concerns made him rethink the matter. "There were certain models," Farino stated, "such as the project Mercury rocket and space capsule, that would be featured in only a single episode. Any miniatures built for those flights could not be amortized over the run of the series–and that made them too expensive to justify. At that point, I put the financial brakes on and went with computer graphics for specific shots."

Computer generated models would be cost-effective for these single-installment spacecraft, but the question remained whether the technique would be aesthetically acceptable, until Area 51 effects supervisor Tim McHugh showed Farino a full CG test–featuring a Gemini capsule in orbit–the company had done for the Dark *Skies* television series. Farino incorrectly assumed that Area 51 had only generated the background, and that the capsule was a miniature. When McHugh apprised him of the capsule's digital origin, Farino reevaluated the use of the technique. "Once he saw that proper lighting and rendering could produce credible results," McHugh said, "Ernie began viewing CGI as a viable adjunct to motion control. It was a way to save money without sacrificing quality."

Visual effects production was housed at Hollywood Center Studios for the first few months, then moved to Hollywood Digital in January 1997. "We offered to take on some of the effects work," noted HD effects producer Bill Romeo, who had worked with Tony To on the Earth 2 TV series, "while simultaneously equipping our facility to meet their production and postproduction needs." Hollywood Digital provided cutting rooms–equipped with Avids using Mediashare–for Go Flight, the production entity set up for *From the Earth to the Moon*, as well as accommodations for the entire visual effects team, which wound up spending nearly a year at the facility.

A 5000-square-foot stage was rented in Van Nuys to house the motion control unit, which would remain operational for eleven months, from March 1997 through January 1998. The stage setup operated around a single fixed element–a thirty-foot camera track. Various auxiliary tracks holding miniatures could be positioned to run parallel or perpendicular to the camera track, depending on the needs of a given shot.

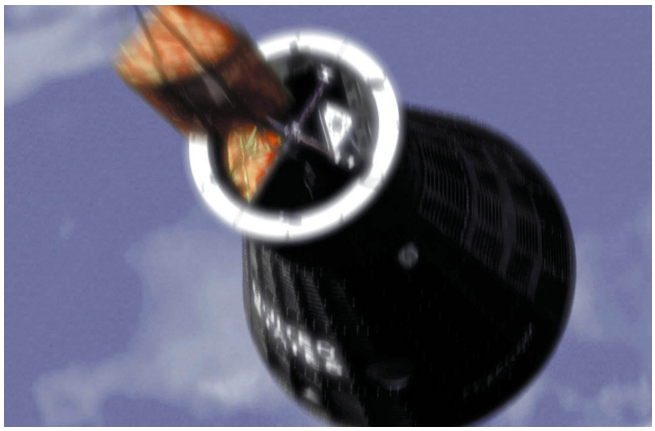
On the motion control stage, effects director of photography Tony Cutrono had to contend with the fact that space imagery has become increasingly familiar, due to the advent of the NASA channel on cable TV, and that lighting cheats when shooting the miniature spacecraft would be noted by savvy audiences. Three basic lighting schemes would be required for the space sequences: Earth orbit, lunar orbit and deep space between planets, where fill light does not exist. "The deep space shots are, by necessity, always cheat situations," stated Farino. "For reference, I went back to 2001, which had a ton of fill light but never looked objectionable."

"Aside from choosing an angle that made the model look good, there wasn't a whole lot I could do about the sun," Cutrono allowed. "But I could do some tasty stuff on the fill side, utilizing reflections on the models and building contrast. The fill light from Earth gave NASA images a blue tint that was particularly visible in the gold foil at the back end of the Gemini capsule. So I decided to capitalize on this naturally occurring event, taking it up a level with just the slightest degree of stylization." Shiny blue material was draped or formed onto cards to create colored reflections. Combined with cotton and white foamcore cloud pieces, the material provided the full range of earth's color scheme as a reflection element.

The series opener, entitled "Can We Do This?," depicted the panicked U.S. reaction to the Soviet Union's successful launch of a man into space and President John F. Kennedy's bold commitment to a successful manned lunar landing by decade's end. That first hour–directed by Hanks–spanned the years 1961 through 1966, covering both the Mercury and Gemini space programs and setting the stage for the eleven subsequent installments, all of which would focus on project Apollo.

Area 51 created the Redstone rocket for the first suborbital flight of Alan B. Shepherd (Ted Levine) and a Mercury capsule for space scenes, building the CG models from voluminous reference materials provided by NASA. Unfortunately, much of the Mercury footage was dropped due to the episode's time constraints. After successful completion of project Mercury, NASA took step two in its three-tiered program to the moon–Gemini. Episode one featured many close views of an unmanned Agena docking vehicle and the two-man Gemini spacecraft. To augment a full-size Gemini capsule custom-built for the production by Guard-Lee–a Florida company that specializes in accurate spacecraft and aircraft simulators–Farino employed small-scale miniatures, contracting with Hunter/Gratzner Industries to provide not only the Gemini capsule in eighth-scale, but also its Agena docking vehicle, plus an Apollo command service module and lunar module. "We made patterns and molded the capsules," said Matthew Gratzner, "then cast them in epoxy and fiberglass. Essentially we created a gigantic eighth-scale model kit. The Gemini capsule's corrugated surface was laser-cut. Matching to the black finish on the real thing meant mixing metallic paints with blacks to create a sheen that served to separate the capsule from the blackness of space. Buffing with steel wool gave it a real fine-grained texture. The craft was fairly fresh-looking, but since it was supposed to have just gone up through the atmosphere, we included some measure of weathering." All of the models were hollow shells featuring aluminum armatures to permit mounting from top, bottom and all sides. "That was essential. These spacecraft would be seen from every conceivable angle over that year on the motion-control stage. They had to be able to rig the models quickly, especially when accommodating the new shots and setups added as production continued."

One of the problems of a year-long shoot was maintaining the models. "We beat them up pretty bad," admitted Tony Cutrono. Fortunately, Carlyle Livingston–who had acted as HGI's crew chief for both Gemini and Agena, then transitioned over to the motion control unit–found a water-soluble underarm spray that helped to maintain the silver leaf sheen on the models. "Every third or fourth shot, Carlyle would repair the finish. He only had to completely replace the silver once."



For a shot of Shepherd's capsule deploying its parachute upon reentry, Area 51 simulated hand-held camera shake in their all-CG depiction.

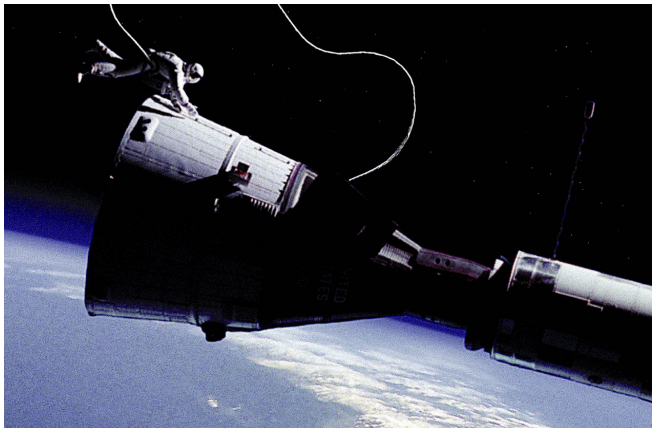
Aware that bluescreen matting would be problematic, due to the abundance of blue fill light in earth-orbit shots, Ernie Farino was leaning towards doing traditional frontlight/backlight passes on the models when Cutrono and his gaffer, Ethan Phillips suggested an orange screen approach. "I found it cut really clean mattes," stated Cutrono. "It was perfect for this kind of work–spacecraft clearly delineated against planets–allowing the models to be completely silhouetted. It was, with out a doubt, the most precise matting process I'd ever worked with."

Gemini's main objective was to demonstrate the capabilities of both astronauts and spacecraft to perform a variety of in-flight tasks. One of these was EVA–extra-vehicular activity–in which an astronaut would venture outside his capsule. Shots depicting the Gemini 4 space walk of Ed White (Chris Isaak) utilized the miniature Gemini capsule and a live bluescreen element of a stuntman

wear ing a spacesuit built by Chris Gilman's Global FX, the company that provided duplicates of Gemini and Apollo spacesuits for all of the show's episodes. That live-action element was then supplemented with a miniature Ed White figure created by HGI's Lulie Newcomb.

A later mission–demonstrating pilot skill in making a rendezvous and then docking with another spacecraft–nearly proved disastrous. After Gemini 8 successfully docked with its Agena target drone, spurious thrusterfire put the stack into a perilous spin, threatening structural failure and requiring a rapid undock and return to Earth. For the motion control model to demonstrate pitch, roll and yaw in the same cut would have meant multiple stops during each take, both to remount the miniature and to alter capsule direction. As a matter of expediency, the most extreme tumbling actions fell to Area 51, which rebuilt its original CG Gemini model to much tighter specifications in order to satisfy Hanks' commitment to authenticity.

Episode one concludes with future moonwalker Buzz Aldrin (Bryan Cranston) astride the Agena. The original intention had been to shoot a space-suited stuntman on a digital blue cylinder that could be replaced with a shot of the miniature Agena. However, the camera move was so sweeping, Farino was concerned about the feasibility of marrying the bluescreen figure with a CG spacecraft, precisely matching the multi-axis moves. An entirely CGI solution was provided by Area 51, which over came Hanks' and To's initial skepticism regarding the viability of creating a CG astronaut by first showing them a test in which just the spacesuit gloves were computer generated and match-move composited over a live astronaut. To and Hanks were so impressed by the digital gloves, they immediately gave McHugh their okay to build a full astronaut synthetically. "What really impressed them was that they couldn't tell which part of the astronaut was real and which wasn't," said Tim McHugh. "We exactly matched the lighting, textures, colors and film grain of the live-action footage."



To reenact a spacewalk by astronaut Buzz Aldrin, Area 51 composited a bluescreened stuntman onto a miniature Gemini capsule and a NASA earth photo.

For a shot whose complex camera move ruled out models and a live actor, Area 51 created an all-CG astronaut and Agena target drone.

The first manned Apollo mission, depicted in episode two–"Apollo 1"–never reached space, as a capsule fire asphyxiated the crew during a launch pad test. The earthbound episode concentrated on the feelings of guilt harbored by the Apollo support crews and on the question of whether or not a moon landing was worth the cost of human lives. In episode three's "We Have Cleared the Tower," the U.S. returns to space–eighteen months behind schedule. AI Effects executed the bulk of visual effects in the third segment, which begins with Apollo 7 astronaut Wally Schirra (Mark Harmon) attending

funeral services for his Apollo 1 comrades. In *Forrest Gump style*, Harmon was incorporated into real news footage of the event. The original photog raphy featured President Lyndon B. Johnson, the father of Gus Grissom–one of the astronauts killed in the accident–and astronaut Jim Lovell. “They wanted to paste Mark Harmon’s head onto Lov ell’s body,” AI Effects co-owner Tony Alderson recalled, “but their uniform ranks were different. So we cut Lovell out and replaced him with Harmon, then put Grissom’s father through arm and coat replace ment to make Harmon fit properly.”

Like the Mercury/Redstone assembly in episode one, the Saturn 1B rocket used to fire Apollo 7 into orbit would be featured only in this single segment. As a result, Ernie Farino decided that CG models–composited into background plates shot in Florida–would suffice for both the rocket and its gantry. Working from reference photos, AI Effects modified Viewpoint DataLabs models, creating image maps for the rocket’s paint job and bump maps of its cor rugated sections. Storyboards mandated extreme down-angle views on the rocket, but detailed photo reference of the pad grounds as they had appeared at the time of the launch was not readily available. NASA film cameras mounted atop the launch pad for Apollo 7 provided a few scant pre-launch frames showing the general layout around the pad, but the level of detail in the grainy images made for poor reference. As a result, AI’s digital background ele ments suffered from lack of resolution, necessitat ing additional enhancement. Since AI had already transitioned onto its next assignment–producing animatic storyboards for the remain ing episodes in the series–the background files were sent to Scott Wheeler at Area 51, who built up the concrete tex tures and tweaked the lighting to create more of a sunlit feel. Area 51 also added imperfections to the camera moves to make them appear naturalistic, as though a cameraman shot them on location.

A number of pre-launch long shots featured the CG Saturn 1B within background plates of the real Pad 34 blockhouse filmed in Florida. Those plates, however, were marred by the presence of modern-day power lines in the midground. “They cut right in front of the rocket and cluttered up the shot,” Alderson said. “So we did a three-way split-screen, losing the sky above the treeline, separating the foreground live-action people out and transform ing the midground–where the trees, blockhouse, roadways and power lines were–into a still frame. We painted the power lines out by stealing bits from the replaced sky background, then ran a film-grain plug-in to match the grain on the actors in the foreground. It was like a big still photo patched into live-action that allowed us to add the Light Wave gantry and rocket, with smoke and sky ele ments in the background.”

More creative work was performed with photo graphic stills. “Near the beginning of the episode,” said Alderson, “there’s an aerial view of the huge vehicle assembly building and rocket gantry. You can see some beach areas and road traffic further off, as well. We started with an old 8x10 color still from NASA that I scanned in and split into pieces. I animated the waves rolling across the beach, then cut out a bunch of cars to create animated traffic, while adding some drift to give the impression of a helicopter shot. It’s been mistaken for a stock shot,

but was really just this Photoshop and AfterEffects gag." Stock footage was used for the liftoff, but one wide shot of the rocket climbing was executed in LightWave. Alderson paneled a Farino-shot daylight smoke element onto a polygon, then placed a lens flare at the base of the CG rocket to illuminate its exhaust trail.

Working solely in the digital realm, AIEffects re-created a period black-and-white photo for a pre-launch scene of the Saturn 1B rocket used to fire Apollo 7 into orbit.

The series' fourth episode, "1968," depicts the flight of Apollo 8 as it orbits round the moon while all hell breaks loose on the home front. An eclectic array of shooting and editing techniques created the series' visual pinnacle with this segment, which captured the staccato pace of that memorable year, marked by multiple assassinations and civil unrest over Vietnam. Except for spacecraft sequences, the episode was filmed in black-and-white, making Apollo 8 the only bit of color in a dark and tumul tuous time. During liftoff, multiple-screen imagery combined monochrome reactions with color stock footage of the first manned Saturn V launch. For story-specific shots of the rocket, the producers obtained an eighteen-foot Saturn V model used in *Apollo 13*, which was rebuilt by lead modeler John Hoffman of Vision Crew Unlimited. "The model was used for closeup in-flight shots done live with prac tical smoke elements," VCU's Evan Jacobs stated. "It was very much an old-school approach to the effects, like those in *The Right Stuff*."

As Apollo 8 climbs toward orbit, staging com mences. An extreme down-angle was called for during stage separation, but the large model could not be configured to work for such a setup. "There wasn't money to build another rocket from scratch," Jacobs remarked, "so we bought a Revell model kit of the Apollo 8 stack and detailed it like crazy. Additionally, it had to be fitted with armatures that permitted the stages to fit together but fall away separately." Tony Cutrono photographed the stag ing se quence horizontally, taking great care to keep the model-movers and jettisoned lower stage from marring the lighting setup. "The stages were detailed inside and out. What amazed me was how well this three-foot model held up. We used it for a shot of the third stage in orbit that appeared in the opening credits of each episode. What you were seeing was only about twelve inches long!"

For an aerial view of the Apollo 7 launch pad, AI scanned a still photograph, then added CG waves and cars and helicopter drift.

Pacific Title/Mirage Studios created a digital burn effect on the jettisoned ring clamp between stages to tie it in with their rocket exhaust animation. Both of these elements were developed by lead Brian Steiner. “We augmented that burn effect with CGI particles,” said visual effects supervisor Ariel Velasco Shaw, “which suggested charred debris. Then we augmented the background plate of earth, adding a ‘powers-of-ten’ move to really sell the speed of the rocket. Our Inferno artist, Jon Tanimoto, did an awesome job, first assembling Cape Canaveral and Florida pieces, then creating this move. He laid out the plate in such a way as to suggest a perspective change as the earth begins to show its curvature.” PTM also designed and executed Apollo thruster and main engine animation effects for the moon flight–work which led to their being chosen to produce the episode’s digital moonscapes.

AI inserted a CG rocket and gantry into a tilt-up plate shot at Cape Canaveral.

In the course of the mission, commander Frank Borman (David Andrews) becomes ill and vomits, sending bits of partially digested food across the cabin. THDX, a division of Title House, picked up the series of shots after attempts by another house proved unusable. “The question everyone asked was, ‘What does zero-g vomit look like?’” recalled digital effects supervisor Bruce Douglas Johnson. “Production had considered buying cream of mush room soup and pouring it in front of a high-speed camera.” When that idea was rejected, THDX tried both 3-D and 2-D approaches, sub mitting test shots that used different techniques in each corner of the frame. Given the various options, production set tled on a particle system look created with Power Animator. Compositor Michael Adkisson then spent two weeks extracting the necessary tracking data from the freeform, hand-held plates. “There were no foreground structures to roto the vomit around,” Adkisson said. “As a result, the shot lacked depth cues indicating how distant the vomit pools were from the camera. By creating layers and letting the foreground vomit go out of focus as it came toward camera, we created a sense of 3-D space. Distaste ful as it was, final comping issues revolved around color–we’d hear that the vomit was too ‘choco-late’ and needed to be more ‘caramel.’”

A location plate, with anachronistic elements deleted, was the basis for an AI digital re-creation of the Apollo 7 liftoff.

After making a successful translunar injection burn, the third stage is jettisoned, leaving the com mand/service module and its crew of three irrevo cably committed to a path that takes them to lunar space. The Kansas City Cosmosphere and Space Center's SpaceWorks division provided a full-scale command module, while HGI fabricated an eighth-scale command module/service module combination, with Niels Nielson acting as crew chief and Adam Lovell as lead. "For our command module's interior," Matthew Gratzner related, "we found this great old Time-Life volume with a tremendous shot of the entire dashboard. We made multiple color xeroxes from that, then cut those up and backed them with bits of styrene arranged to give the illu sion of depth. When you took a good look inside the window, it read like a real cockpit, with all the panel separations."

Apollo 8 enters lunar orbit, affording the first lengthy, closeup look at the moon's pockmarked surface. A number of companies approached by Farino had intended to use procedural systems to generate the moonscapes–creating the imagery via fractal mechanisms and modeling. Eschewing that approach, Farino decided to convert existing lunar photography into geometry via the use of deformation and displacement maps. A sequence of extremely high-resolution images–which had been shot from a camera mounted in an orbiting command module on later Apollo missions–was pieced together to form some of the moonscapes, while the Lunar Planetary Institute and the U.S. Geological Service provided other sources.

AI Effects principals Frank H. Isaacs and Tony Alderson discuss construction of a shot.

Pacific Title/Mirage Studios synthesized the moonscapes. "The NASA footage from their lunar flyovers tended to look soft and read really poorly," Ariel Velasco Shaw remarked. "Bruce Richmond and Ernie had gotten a pretty good idea from the astro nauts of what the surface was like, so after discussing it with them, we were able to augment the reference stills with hand-painted textures prior to deformation and mapping." PTM supplied some 135 shots for episodes four, six, seven and twelve – nearly a third of the total effects shot load. The confluence of forces that brought Pacific Title and Mirage together proved to be of considerable bene fit to HBO. In addition to touching up astronomical reference–occasionally shadows required repaint ing to ensure that displacement maps would not create false drop-offs–and performing texture map conversion, PacTitle provided a huge library of space elements that rivaled NASA's own.

Digital effects supervisor Dave Altenau and vis ual effects producer Dave Taritero spearheaded the PTM moonscape project, which expanded to include sunrise and earthrise shots. "Digital artist Guy Wil liams went through tremendous pains to detail out the sunrise with lens flares," Shaw said. "He made sure the Apollo's reaction control system thrusters were emitting bursts which turned into sprinkles of light against the sunrise. Bruce Richmond had chal lenged us to make the visuals match the im pressive sound element he'd already settled on. So we animated the crawling shadows of the termina tor line coming forward, which helped create the majestic feel of the moment."

PTM's digital kicks and flares helped to enhance the textured fill lighting created by Tony Cutrono on the motion control stage. "With these small spacecraft models only a few feet off the ground," Cutrono commented, "I couldn't use translights or spheres–there wasn't anyplace to hide them. So for the lunar orbit shots, I used gray cards as fill, devoid of warmth and color. White bits broke up the gray to suggest a pockmarked terrain." The dark side of the moon proved another dicey lighting proposition. "There's no light–none at all. It wasn't like the shots featuring spacecraft in deep space, where I could create a black terminator line on the model to demonstrate the absence of light sources beyond the sun. I watched *Apollo 13*, saw how they had cheated it, and wound up doing likewise. To keep the light sourceless, I made it very flat, with no edging."

Modelmakers at Vision Crew Unlimited built a prototype lunar landing vehicle for a scene in which the craft crashes during a desert test flight.

Such lighting cheats were not the only occa-sions in which reality bowed to artistic considerations. A shot of the command module in lunar orbit, for example, included the craft's running lights–even though, in reality, the lights were only engaged during docking maneuvers. "We always shot a pass with the exterior lights running," Farino explained, "since there was the chance an element could be reused for a rendezvous shot. The light pass was insurance. When PTM assembled this lunar orbit shot, they unwittingly included the running light pass. And when the shot appeared in dailies, Tom and I 'oohed' and 'ahhed' over it. I repeated astro naut consultant Dave Scott's dictum that the run ning lights are only used during docking maneuvers to Tom. He nodded, and said, 'Even so...that looks really great!' So the little red running lights stayed on. I didn't really have to remind Tom about this stuff, as he knows a tremendous amount about space. If Dave Scott, our consultant, wasn't around, we'd usually just ask Tom. But this was more of an aesthetic choice in any case, which occasionally worked better visually."

The company also refurbished the Saturn V rocket and gantry built originally for Apollo 13.

Episode five, "Spider," detailed the rough road traversed by lunar module builders up through the initial two deployments of the craft on Apollo 9 and 10. Most of the space footage in the episode came from NASA stock, while other scenes utilized an actual lunar module simulator obtained from NASA and a lunar module replica from SpaceWorks. A miniature, built by HGI, was dressed with thermal blankets made of gold mylar and was rigged with stepper motors to extend its landing legs. Rather than a slow dramatic unfolding of legs–like the Aries moonlanding in 2001–Ernie Farino insisted that the appendages snap open, duplicating the spring-loaded motion of the real lander's legs. "To physically link the command module to the lunar module," explained Matthew Gratzner, "we came up with a yoke-shaped model-mover post–half of which fit into each miniature. The docked config uration gave us about six-and-a-half feet of model that could be put through rotation or whatever else was needed."

"Mare Tranquilitatis" chronicled the flight of Apollo 11, first detailing incidents in the lives of the crew prior to the mission. While flying a lunar landing test vehicle–known as the LLRV–Neil Armstrong (Tony Goldwyn) loses control and has to eject while the craft crashes and bursts into flame. Production turned up an undamaged LLRV–minus engine. While some shots could be obtained with the full-sized unit, the majority would be accom plished with a quarter-scale miniature built by VCU. "We kept our model light," Evan Jacobs remarked, "like the real LLRV. We soldered it from brass, keep ing everything thin-walled except for the engine. CO2 was plumbed for the thrusters."

Shot alongside its larger brother at Edwards Air Force base, the LLRV model was mounted on a gimbaled green post that was attached to a Chap man crane and actuated by radio control to perform multi-axis movement. “Ernie hit upon the idea of shooting the model outdoors and puppeteering it through a series of moves,” Jacobs stated. “That gave us every axis of motion needed, plus we could get a lot of takes done quickly. The motion had a genuine sense of uncertainty–it didn’t have that motion control, programmed look at all.”

Unfortunately, VCU’s CO2 thrusters failed to register against the bright sky, so additional bursts were filmed against black on stage. Animator and visual effects veteran Randall William Cook, who had been hired to do LLRV rig removals, wound up compositing the thruster elements, as well. “Randy flopped and repositioned them to good effect,” ex plained Farino. “Choosing an animator who un der stands move dynamics to handle the scene worked terrifically well.” But in editorial, additional shots were deemed necessary. Production manager Cam eron D. Stevning organized a week-long desert shoot in Palmdale to handle additional LLRV work, plus a variety of other plates to be shot in daylight against a real sky. A third and final group of LLRV shots took place in the parking lot of the motion control stage and on the roof of Hollywood Digital. “We set up a bluescreen to shoot the model arcing up and careening back. Then I took a series of sky stills from the Hollywood Digital rooftop to create a panoramic background.”

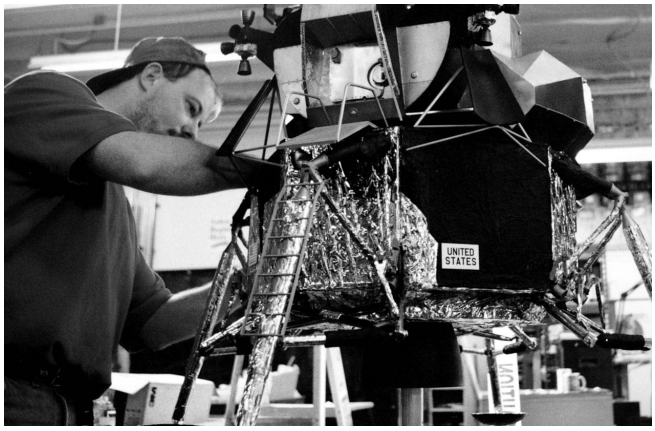
Armstrong survives the crash and goes on to command the first lunar landing mission. After narrowly averting a computer-directed landing in side a huge crater, Eagle touches down in the Sea of Tranquillity. To recreate the astronauts’ lunar excursion, a blimp hangar at the Tustin Marine Air Corps Station was converted into a shooting stage for the live-action moonscape scenes. The set meas ured 38,000 square feet and sported a sixty-foot-tall black backing extending nearly a quarter-mile. To create the impression of a huge sunlike single light source, director of photography Gale Tattersall aimed twenty-one 10K xenon light units toward a polished aluminum water-cooled mirror, mounted at a raking angle above the landscape.

Production designer Richard Toyon built the moonscape so it could be redressed and reconfig ured to depict the various topographies seen in six lunar missions, which ranged from flat lunar ‘seas’ to sloping mounds to fairly craggy terrain. A logis tical problem with the location necessitated the employment of a separate on-set supervisor for the lunar scenes. “There were huge skylights at the top of the Tustin hangar that couldn’t be covered up,” Farino explained, “which meant night shooting for three or four weeks. We brought in Glenn Neufeld to supervise those shots at night while I handled the rest of the day unit stuff.”

The moon set proved nearly as problematic photographically as its offworld counterpart, with unwanted reflections in space helmet faceplates cropping up with annoying frequency until it was discovered that a Technocrane-mounted camera could be successfully hidden from the mirrored faceplate’s fishbowl-like surface. To simulate the lighter lunar gravity, Tattersall ordered a pair of helium balloons measuring fifty-six feet high and ten feet in diameter, each of which was attached to stuntmen in spacesuits. The tethered balloons off set a significant portion of the performers’ weight, enabling them to bunny-hop convincingly across the lunar terrain set.

Bridging the gap between the full-size set and Pacific Title/Mirage’s digital moonscapes was a quarter-scale set constructed by Toyon at the far end of the Tustin hangar. “This ‘mini-moonscape’

was about seventy-five by seventy-five," Farino said. "We acquired the quarter-scale lunar module built for *Apollo 13*, made extensive renovations and up grades–essentially rebuilding most of it–then shot some high-speed material of the LM touching down, making flyovers, and closeups of its footpad as we traveled down to the surface with it and ob served touchdown. All of this was done over four nights, concurrent with the main unit shoot."



Modelmakers Logan Payne and James Peterson of Hunter/ Gratzner Industries apply final detailing to an eighth-scale Apollo lunar module.

With the successful moon landing, the Apollo epoch had reached its zenith in the eyes of the pub lic. For the scientific community, however, the real work had only just begun. The flight of Apollo 12 – commemorated in episode seven as "That's All There Is"–began with a bang, as lightning bolts hammered the Saturn V shortly after launch, then continued downward, striking the rocket gantry, as well. The twenty-eight-foot miniature gantry–another leftover from *Apollo 13*–was restored by VCU under the lead of modelmaker Brian Remaley. "We had to strip it down to the bare metal frame–which was in really good shape," said Evan Jacobs. "The gantry had to be filmable from all angles, so we completely redetailed it. Although we did not motorize the gantry arms, they could be ar ticulated to any position." The revamped model was filmed during the week-long shoot in Palmdale.

The astronauts' exploration of the moon was more extensive than the previous mission's brief excursion. Depicting their jaunts required PTM to create digital scene extensions and matte paintings, expanding on the dimensions of the Tustin stage. Rachel Kelly, formerly of Digital Domain, created numerous matte paintings and texture maps for these moonscapes, many of which required exten sive 3-D tracking. "There weren't any high-contrast elements to track," remarked Ariel Velasco Shaw. "Every thing was gray. You couldn't hide the seams with atmospheric and particulate matter either, since there's no air on the moon. Even with these difficulties, I'd challenge anyone to pick out our extensions from the shots featuring unenhanced landscapes." PTM's shots had to match with not only the production footage, but with the varying sensibilities brought to focus on different install ments. "The shows were essentially docudramas, but we found, in working on several, that each epi sode had its own tone–some were lyrical, while others were darker, more serious."

With *Apollo 13* still a recent and vivid memory, Hanks and company wisely chose to avoid direct comparisons in "We Interrupt This Program," in stead focusing on terrestrial goings-on–specific ally, the beginning of the end for 'fair play' ethics in journalism. The next episode, "For Miles and Miles," examined the sophomore flight of Alan Shepherd. A rockier, less-hospitable moonscape was achieved by first redressing the Tustin set, then augmenting and extending that vista with digital matte paint ings, which were created on set before undergoing later refinement. "We went to Tustin with a small Silicon Graphics station, Matador paint and Chal ice," Bruce Richmond stated. "We knew that all of the moon sequences were going to require some enhancement, and I hoped we could lock into a look for the scene extensions while shooting was still going on. It would've been

great to finish the paintings on site, but that system couldn't give us hand-tracking, which was essential to produce finals. Matador got us pointed in the right direction, but matte artist Laurent Ben-Mimoun wound up finishing the paintings at POP–a company that had performed R&D for us early on." POP also per-formed compositing duties for the next episode, "Galileo was Right," an episode that focused on the successful effort to transform test pilot astro nauts into field scientists imbued with a passion for lunar geology.

Episode eleven, "The Original Wives Club," tied in chronologically with the progression of Apollo missions through a moment aboard Apollo 16 when an astronaut's lost wedding ring floats through the capsule, nearly escaping into space before being recovered. Except for the very last shot in the scene–showing the ring in an astronaut's hand–every ring image was computer generated by THDX. "There were concerns about focus issues while they shot the background plates in Florida," Bruce Johnson stated. "Everything in the command module was shot pretty much wide-open, with zero depth. The backgrounds were going to have a lot of out-of-focus images that would be rack-focused as though a camera is watching the ring drift away. Ernie Farino wanted to know if it would work better if they shot the plates sharp and let us defocus the image. We decided against that, as there are all sorts of issues in defocusing that don't correspond to bar rel distortions and other 3-D aspects of a lens go-ing out of focus."

Working without tracking data or set measure ments, THDX relied on Farino's description of the on-set lighting. "I think one of the key failures in 3-D comes from compromising on lighting," noted John son, "either by downplaying its importance or by not having the necessary data. It was very im portant to me that we match Gale Tattersall's look. Painstakingly, Inaki Imaz determined the location of the set lights, then played with the intensities of those lights for a time before he could match them completely."

Scrutiny was required to accurately deter mine the ring's specular qualities. "One thinks of gold as wholly reflective," Imaz commented, "but people don't polish their rings constantly. I studied a wed ding ring for a few days and found that the inner surface is more polished because it's against skin, whereas the outside becomes oxidized. So I spent a long time texturing this with Studio Paint before handing it off to Mike Adkisson, who did his best to degrade the gold, adding grain and blurring the image." Even though the final output would be video resolution D-1, THDX employed their SGIs to render at a higher color-depth, allowing Adkisson to selectively discard high- or low-end aspects that did not work, while still retaining broadcast qual-ity resolution.

The series' final installment, "*Le Voyage Dans La Lune*," establishes a link between the power of imagination and the will to accomplish out-of-this-world goals, intercutting between the making of Georges Melies' seminal space fantasy *A Trip to the Moon* and the crew of *Apollo 17*, which featured the sole geologist-astronaut to actually walk on the moon, Harrison Schmidt (Tom Amandes). Pacific Title/Mirage again handled the moonscapes. Additionally, to depict Melies' Paris, PTM's Rachel Kelly painted an elaborate cityscape, which was embel lished with a *Citizen Kane*-like camera move down through the glass-roofed film studio. Tom Hanks co-authored the episode and appeared in the guise as Melies' assistant, while series cinematographer Tattersall cameoed as his cameraman.

By the time production wrapped in the fall of 1997, the live-action shoot had ranged from coast to coast, logging in at one hundred different locations. The visual effects unit, which had become

operational with the hiring of Ernie Farino in Octo ber 1996, continued to function until mere weeks prior to HBO's airing of the series in April and May. For the final eight months of post, Bruce Richmond, now wearing the hat of visual effects producer, re mained on site with Hollywood Digital. Todd AO –already signed to handle the sound–had subse quently merged with HD, allowing the postproduction thrust to be consolidated at one site. Digital compositor Eroc Moralls and assistant R. Carter Lassy worked six- and seven-day weeks with Rich mond to finish the load, which varied according to editorial dictates. "We started with 275 effects shots, but wound up with nearly 200 more," Tony Cutrono stated. "Once HBO saw our footage and understood what we were doing photographically, they wanted more shots. Then, during editing, they saw just how much more was needed to tell the story. Fortunately, even with these additions, Ernie and Bruce Richmond maintained the look I had in tended, not blowing things out or letting them go flat." In addition to the 468 effects shots, another two hundred cuts required wire and rig removals or the addition of camera shake.

Living with visions of orbiting spacecraft took its toll on some. "About a year into this project," Evan Jacobs recalled, "Ernie Farino came out of a restaurant one night and stopped dead in his tracks. He stared up into the sky at a full moon, studying it for several minutes. People were passing him, prob ably thinking he was crazy, but Ernie found himself completely caught up in the moment, trying to determine how the moon's color and luminosity could best be captured on film."

It is an unfortunate fact that the bulk of data gathered from space exploration in the *Sixties and Seventies* is unrecoverable, having been stored on outdated computer systems with unconvertible file records. While NASA's ubiquitous offshoots–pens capable of writing upside down, Teflon-coated fry ing pans and thermal 'space' blankets–remain shiny symbols of the space program, most of the true scientific riches garnered have been lost. Best estimates indicate that redeveloping the technol ogy for a manned return to the lunar surface could not be achieved for another fifteen years–and only then by mustering an effort the likes of which has not been seen since the days of Apollo. Astronaut Jim Lovell titled his book on the ill-fated flight of *Apollo 13 Lost Moon*, an acknowledgment of what he had missed when the mission went awry. Coming full circle from that disappointment, series execu tive producer Tom Hanks–the actor who portrayed Lovell in *Apollo 13*–has, in a tangible way, restored the magic and sense of wonder inherent in the voyage from the earth to the moon.

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BLADE
GOING FOR THE JUGULAR

ARTICLE BY MATTHEW J. MACDONALD

Vampires. The word itself conjures images from dozens of films. Condemned to walk the line sepa rating this life from the next, these nocturnal pred ators have been a Hollywood horror mainstay since the bygone days of silent film. From the creepily cadaverous bloodsucker of Nosferatu to the charm ing antebellum socialites of *Interview With the Vampire*, the sanguinary exploits of these undead icons have been explored in nearly every conceiv able way. It would seem, therefore, that the mythol ogy of these beings has run its course, and horror movie enthusiasts have seen it all. Until now.

Based on an obscure Marvel Comics character, New Line Cinema's *Blade* is the story of an unstop pable avenger–played by Wesley Snipes–biolog ically caught between two worlds and set against a legion of supernatural foes. The movie opens with the violent image of an unborn baby being jolted in the womb as its mother is attacked and slain by vampire Deacon Frost (Stephen Dorff). The infant's umbilical bloodstream is tainted with the attacker's venomous blood, and he is born with the genetic characteristics of both human beings and vampires. Blessed with incredible strength and heightened senses, the child–who bears the name '*Blade*'–is taken in by Abraham Whistler (Kris Kristofferson), a grizzled crusader with considerable experience in deal ing with the undead. Realizing that the young anom aly is filled with hatred toward the creatures that have defiled his very existence, Whistler trains and mili tarizes *Blade* against the vampires' clan destine society–and, most especially, against the meg alomaniac Frost.

Director Stephen Norrington faced formidable obstacles in realizing what would become a multi faceted production. A former visual effects artist skilled in animatronics and makeup, Norrington had worked for such stellar movie magicians as Stan Winston and Rick Baker, and had been counted among the ranks of Jim Henson's Creature Shop. In the early nineties, he branched out into directing commercials and music videos, an endeavor that introduced him to computer graphics and culmi nated with *Death Machine*, his 1993 feature debut. The movie caught the eye of talent agent Robert Newman who brought Norrington stateside. After a private viewing of *Death Machine*, Wesley Snipes–already slated to star in and co-produce *Blade*–arranged a meeting with Norrington; and before long, Norrington's assignment as *Blade* director was set in stone.

Norrington knew from his own past trial-and-error experiences that a thorough breakdown of David S. Goyer's screenplay and extensive, detailed storyboards were the only way to ensure an efficient, cohesive production. Flanked by a team of artists led by Marc Messenger, Arthur Lee and Jason Brubaker, Norrington set about dividing each sequence into precise segments and deter mining dynamic visual guidelines for the film. Then, enlisting his *Death Machine* producer Matthew Justice as visual effects producer, Chuck Comisky as visual effects supervisor and Ed Irastorza as visual effects coor dinator, Norrington confronted the immediate task of assembling an army of effects specialists. "We were looking for people who could give us high-end 3-D computer graphics and combine those convinc ingly and photorealistically with miniatures and prosthetics," stated Norrington, "while also being able to work within my specific artistic concepts and deal with my 'dangerous' level of visual effects knowledge. I had already designed in detail what I wanted to see in this film; but on-set discussion and the exigencies of shooting and editing always throw up endless revisions and improvements. In order to accomplish things within budget, we had to facilitate the work through vendors who were willing to roll with the punches."

Director Stephen Norrington confers with makeup creator Greg Cannom on the set of Blade, an action-thriller about an immortal warrior who does battle with modern-day vampires.

The first major narrative sequence also proved to be one of the most effects heavy. A sultry female vampire lures an unsuspecting man into a nightclub frequented exclusively by her bloodthirsty brethren. "During a night of frenzied dancing," commented Matthew Justice, "the ceilings erupt in showers of blood, drenching the young, writhing vampires and causing them to go into ecstacy. Just as the victim is about to be attacked, *Blade* turns up, wasting all the vampires with a very cool array of weapons. In this film, a lot of the old vampire traditions hold true: vampires are severely allergic to garlic and silver; and when they are staked through the head or heart, rather than dying, they disintegrate." The disintegration effect, as seen in *Blade*, could be likened to the burning of a cigarette. "From the point of impact, the vampire's skin begins to burn, revealing ash below it. The skeleton is revealed beneath that, and the victim finally disseminates into particles and ash that leave a black stain in their wake."

For the '*Club Blood*' sequence, as it was called, thirty effects shots were produced by Flat Earth Productions, which drew on Norrington's stylistic storyboards to develop a succession of events for each vampire's violent demise. "First we came up with a computer generated sequence for the 'burn aways' that Stephen could look at and work with," said Flat Earth digital composite supervisor Kevin Kutchaver. "He would go through the shots, some times frame by frame, and designate how far he

For abundant scenes of vampire destruction, Flat Earth Productions created a layered digital effect in which the creatures' undead flesh immolates in a flash, leaving

wanted every shot to go–how much skeleton and ash he wanted to see. He let us know exactly what he wanted visually, from the glowing embers inside the vampires' bodies to the exact amounts of ash and bone fragments we were to animate."

skeletal remains which then disintegrate into ash and dust.

For abundant scenes of vampire destruction, Flat Earth Productions created a layered digital effect in which the creatures' undead flesh immolates in a flash, leaving skeletal remains which then disintegrate into ash and dust.

The more horrific elements in the original tests for the *Club Blood* sequence were ultimately toned down. "We had things like CG blood splattering the walls, and pieces of heart flying around," said 3-D supervisor Everett Burrell. "Knowing Stephen was an ex-makeup-effects guy, we thought he'd appre ciate that kind of detail. He did; but even tually he had us tone things down, probably because of the already excessive amounts of blood in the scene. We wound up changing the crimson bursts into flying ash."

Once the vampire disintegration parameters were set, the Flat Earth team was charged with cre ating layered passes that could be dupli cated for each creature's demise. Puppetmaster software was used to pull the multiple elements together and animate them as a whole. "Puppet master allowed us to animate a CG skeleton, fitting different models over it for each separate part of the effect," stated Kutchaver. "It was like those Russian dolls where you open one and find another smaller one within. The layer right atop the skeleton was our 'ash pass,' resem bling Pompeii victims. The one over that was the 'ember pass,' with a kind of molten lava look to it, complete with red burns and cracks. Finally, covering the entire computer model was our 'skin pass,' which was actually a rotoscoping projection effect. Our animators would take the actor from the original background plate and paint him out of every single shot so that our burnaway layers could be implemented. Then, for the skin pass, we would simply front-project the original image from the plate onto the models, making sure they lined up." Random-looking, 'jigsaw-puzzle' transitions from the projected skin pass revealed the disintegrating layers beneath–a difficult and time-consuming part of the overall compositing process.

To effectively place the digital models into the background plates, 3-D animation supervisor Doug Beswick and his match-move team used LightWave software, carefully tracking and duplicating the movements of each vampire victim. "There were really two parts to the match-move," said Beswick. "The first was the camera match-move, where we went into the 3-D computer environment and liter ally duplicated, by hand, the tilting and panning qualities Stephen's hand-held footage exhibited." The second part of the match-move was the key-framing. "After lining the skeleton up to the actor, we would key-frame the wildly gesticulating move ments of each performer at specific frames, allow ing the computer to fill in the motion between those frames on the CG model. We had to do a lot of experimenting, because lens information was not always available and LightWave can't duplicate the perspective shifts and warping effects caused by an anamorphic lens; so we had to literally scale and size objects as we match-moved."

Recreating the on-set environment brought ad ditional problems to the fore. “In addition to the obvious 3-D aspects, such as the characters,” said Flat Earth visual effects supervisor Kevin O’Neill, “we had to recreate the atmosphere throughout each shot. Because there were so many anomalies in a given shot–volumetric lights, ambient smoke, lighting flares–we had to introduce those environ mental variables throughout each shot once the 3-D burnaway effects were in place.”

For a subway fight scene, actors in a tunnel set were combined with a CG train created by Richard ‘Doc’ Baily and composited at Digiscope.

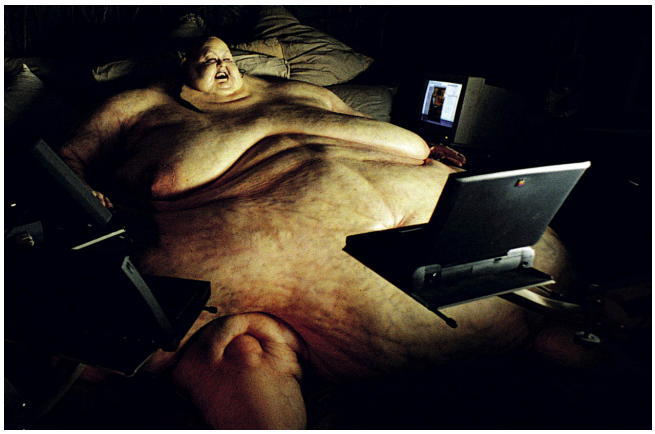
In addition to its *Club Blood* work, Flat Earth produced a twilight shot of a metropolitan skyline with an imaginary high-rise nestled among real buildings. Based on one of Norrington’s elaborate, technical sketches, the skyline shot started with an aerial view of Manhattan, enhanced with a fabri cated towering edifice inhabited by Deacon Frost. As the shot was storyboarded, the building would be seen fairly close in frame all during the long, sin gular take, and would reflect the surrounding urban architecture and light sources. Extensive CG modeling and texture mapping were needed. “Every piece of available software was called into service to realize this incredible shot,” said Kutchaver. “It was probably our biggest team effort on the show.” Flat Earth’s computer graphics artists set to work building the basic skyscraper configuration from scratch, simultaneously covering up the preexisting structure in the aerial plate. To create photoreal re flectivity, shadow and refracted light sources that would track naturally as the camera traversed the skyscraper’s surface, *Robert* Peppler constructed a ring of 3-D buildings in the computer–unseen by the virtual camera, yet each with its own unique pattern of light that would reflect on the in-frame tower. A harsh blue lens flare gave the make-believe structure an added element of realism. “There was an existing lens flare on the real building that had flared the whole plate out. Stephen loved that and wanted us to match it exactly; so half of the flare you see in the film was a 2-D computer generated light source matched to the existing plate.” Light hearted touches added to the CG building included tiny vampire fangs on the CG ducks in a rooftop pond and a life-size bronze statue of Kevin Sorbo–star of the Hercules TV show for which Flat Earth is the effects provider–on the penthouse deck.

Blade (Wesley Snipes) severs the arm of vampire Deacon Frost (Stephen Dorff) in another Digiscope shot.

While the *Club Blood* opening featured a sizable share of the film’s visual effects, the climax was even more effects-laden. Played out in the ancient core of an exhumed shrine known as the Temple of Eternal Night, the scene has Deacon Frost abduct ing twelve vampire lords to bring about ‘*La Magra*’s *Prophecy*,’ which–according to vampire lore– will occur when the elders are arranged in perfect sym metry against the temple’s icon-emblazoned walls. Having accomplished this crucial feat, Frost releases the spirit of an ancient warrior, whose limitless power penetrates Frost’s own body.

Blue Sky | VIFX, under visual effects supervisor Richard Hollander, was responsible for creating elements of both the temple itself and the spectral wraiths that are released in the course of Frost's unholy ceremony. Although the temple had been represented by two full-size sets–consisting of the top two stories and a bottom floor–the sets lacked the connecting five stories of architecture. Conse quently, full views of the temple needed to be real ized in min iature. "The Temple of Eternal Night was a beautiful fifth-scale model," remarked Justice, "com plete with eight stories devised in stunning detail. *Blue Sky* | VIFX shot a whole array of passes motion con trol, some of which were used simply as straight miniature plates, while others were match-moved to existing live-action footage."

Among the makeup and prosthetics effects provided by Cannom Creations was a severely fire-charred bloodsucker on the mend.



On a much larger scale, the Cannom team also supplied a grotesquely obese vampire librarian.

The facility also handled the creation of the spectral wraiths. "As the prophecy begins to come true," stated Justice, "lightning strikes the lords, who begin to disintegrate, issuing forth skeletal apparitions that dive-bomb through Frost, flying in and out of him, enhancing his power with each penetration." The wraith sequence became a mar riage of Norrington's creative input and the com puter expertise of *Blue Sky* | VIFX's animation team, headed by supervisor Daniele Colojacomo and lead animator Chow Emrich. "The original wraith design was sculpted in clay by Stephen Norrington. Those sculptures were molded, cast in a suitable model ing material, then scanned into the computer." The resulting computer images were texture-mapped onto 3-D geometry to make the wraiths look as photorealistic as possible.

"Our goal at the start was to visibly depict the wraiths trying to escape the vampire lords' bodies," elaborated *Blue Sky* | VIFX digital effects supervisor Antoine Dürr. "We wanted an explosive element to enhance the believability of the bursts. Thus, rather than trying to use a CG skeleton, we decided to shoot practical skeletons, air-ramming each from below to create a wild array of flying pieces. Scott Schneider and his model shop crew prepped sets of skeletons, scoring them internally to guide the subsequent breakups. Separate heads and bodies were shot–a pair for each lord that disintegrates. This facilitated a variety of dynamics that would have taken a long time to make believable in CG. Before the skeletons explode, however, wraiths are seen trying to claw their way out of the partially burned lords' heads. Cheryl Budgett, the composit ing supervisor, and her crew worked closely with the 3-D animators to make the animated wraith heads look like they were violently tearing their way out. Artistic 2-D warps were matched to 3-D clawing action, all synchronized to the burn reveals. Once the burning action begins, the lords disinte grate. Ha Roda,

the 3-D supervisor, and her crew generated embers, ashes and other pyrotechnic CG bits, each of which lasted only a handful of frames. The resulting composites thus contain a large amount of activity in a very short time span, enhancing the visceral and frenetic quality of the sequence."

Other effects in the sequence were contributed by Digiscope. "The lightning that builds outside the temple was painted by Lawrence Carroll," recalled Digiscope digital effects supervisor Dion Hatch. "Using a still photograph for the background and some daytime stock cloud footage that he timed for night, Lawrence created a foreboding electrical storm." Lightning strikes within the temple, as well, hitting the elders. "A lot of thought went into the design of the inside lightning. Stephen wanted it to look different–flat, like a knife blade, and with a jerky, energetic movement. Todd Mesher came up with the original look with Stephen. A single bolt was animated in Electric Image and stretched on the Y-axis. The edges were then blurred and tracked to the foreheads of the elders. Brennan Prevatt was the lightning compositing guru, constructing the light rays that emanated from the glyphs using Sapphires Spark and Edge Rays. He also imported into the Inferno a Viewpoint DataLabs human skel eton and, using 3-D geometry and a lot of paint work, created a human X-ray effect."

Earlier in the film, Digiscope provided animated taser effects. "There was a lot of discussion about different ways of doing the tasers," said Hatch. "At one point, *Blade* is subdued by Frost's taser-armed goons in a room whose walls and floor are totally white. The problem of animating tasers over white was obvious. Originally, we tried doing a double output on the film recorder. First we'd lay down the back ground with the tasers, then we'd backwind the recorder and double-expose the tasers only. It worked pretty well, but it wasn't time-effective. In the end, it was done strictly as a paint effect, with artist Wenden Baldwin painting the tasers on the Domino. She composited using a light-density hold out matte and then intensifying the lasers by color-correcting through the beauty matte."

The Domino system was used on about a third of Digiscope's more than two hundred *Blade* shots. "Domino has a great paint package," noted Hatch. "For an establishing shot of Moscow's Red Square at the end of the movie, for example, artist Naomi Sato transformed a summer's eve in Red Square–which was crowded with people–into a cold winter night on the Domino. Stephen wanted the people out of the shot and the trees and buildings to be laden with snow. Naomi finished the matte painting by layering in four falling snow plates in front and behind the different structures."

Digiscope created stylized lightning effects for the film's finale in which a dozen vampire lords are sacrificed in a ceremony designed to unleash an all-powerful entity upon the world.

In the course of the finale, a furious showdown ensues between *Blade* and the now fully empowered Frost. Initially, the movie was to end with a much more effects-driven sequence featuring sixty com puter generated shots and Stephen Dorff as a fan tastic blood monster. "But after testing," remarked Norrington, "we realized that finale was different in tone than the rest of the movie. It was too cartoony, too insane and too impersonal. So we

changed the concept, coming up with a hand-to-hand clash that is a final duel between the two main characters, rather than a pointless spectacle of expensive vis ual effects. Unfortunately, we had already paid for most of them."

One vendor that contributed to the final hand-to-hand combat sequence was Image Savant, whose proprietor and sole employee is maverick digital effects artist Richard 'Doc' Baily. "Directors come to me because I'm specialized," stated Baily. "Like a custom automotive paint shop that does killer hood flames, I create digital images you simply can't get anywhere else." Such specialized digital images were needed for shots of Frost being sliced in two by *Blade*'s sword. His body splits apart, then rejoins, apparently without harm. To achieve the shot, Dorff had been filmed motion control against bluescreen, on a rig designed by Norrington and built by special effects coordinator John Hartigan and his crew. The camera move was then repeated on a torso prosthetic, also filmed bluescreen and sliced through with a sword. The two bluescreen elements were integrated and digitally enhanced by Baily, who computer generated tendrils of blood and gore being stretched to their limit and then finally reforming. The shot was composited by Steve Meyer at 525 Post.

When lightning strikes the undead lords, they begin to disintegrate, releasing spectral wraiths that soar about the ceremonial chamber in a sequence created by Blue Sky | VIFX.

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Less obviously an effect was a train that was computer generated by Baily for a confrontation between *Blade* and his vampire foes within a subway tunnel. “The characters are fighting on a very nar row landing,” said Baily, “and then this train goes by, just inches away. There was no way this could have been filmed in a real tunnel with a real train, because everybody would have died in the process. So production built a four-hundred-foot tunnel and we filmed the actors in the set with movable eight-by-four-foot greenscreen panels situated where the train should be. What we wound up with were all these cuts with the actors in the set and this 3-D space defined by greenscreen panels that went off into the distance. Those panels defined the lead ing edge of the train as it would be going by camera, very close. They also allowed us to roto the actors later on.” Incorporated into that footage was a CG train built by Baily and animated for each of thirty-eight required shots. The sequence was composited by Digiscope, which added sparks, shadows, inter active light, explosions and debris.

Shots of the skeletal forms emerging and shattering in explosive bursts combined computer generated imagery with practical skeletons filmed on stage by effects director of photography Dave Stump.

Assigned to Cannom Creations were basic blood and injury makeups, requisite vampire fangs, and a range of animatronic puppets. All of the makeup effects were heavily influenced by the director’s design sense. “Stephen was involved in a lot of the design process,” said Cannom Creations makeup effects producer Keith VanderLaan. “It wasn’t that he wanted to design all the stuff himself; but he wanted to see what we were doing as we went along–as most directors do. He’s incredibly visual, and he knew immediately if he liked the direction we were going in or not. He was very helpful.”

One of the most complicated makeups was for the vampire Quinn (Donal Logue) who is horribly burned, then regenerated, requiring multiple make ups showing the character in stages of healing. A full-body puppet was also built for a shot of his being set ablaze. “Since the puppet was going to be set on fire,” commented VanderLaan, “we made it out of a flame-retardant material. To give it a lot of action and movement, we made it a hinged pup pet and puppeteered it through a wall of the set with rods.”

Cannom Creations’ most striking contribution was for a scene in which *Blade* and his hematol o gist ally Karen (N’Bushe Wright) meet Pearl, an an drogynous, astoundingly obese vampire who acts as librarian and guardian of ancient supernatural texts. The character was designed and fabricated under the supervision of Cannom art director Miles Teves. “I did a couple of line drawings,” said Teves, “but Stephen wanted the character much wider than what I’d drawn. He took one of my sketches, scanned it into a computer, doubled its width and gave it to me as reference. Based on

that, I redrew it, got Stephen's approval, and then sculpted a ma quette of Pearl's basic body without limbs." When that maquette was approved, it was molded, cast and sliced into sections that were then scaled up to full size. From those, a wooden frame was built and covered in chicken wire and fiberglass. "I sculpted over that structure in water-based clay. The sculp ture was so big and so weighty, I sculpted it on a trailer to facilitate its transportation to the mold-making team–a group of craftsmen that special-ize in making large-scale molds."

After a cast was made of the torso, Teves still had to sculpt the enormous arms and legs, as well as facial appliances for actor Eric Edwards who would inhabit the blubbery construct. "The rolls of body fat were convenient places for each limb to meet up with the rest of the body. The head was sculpted separately over a lifecast of the actor. It had huge cheeks that rolled down and could be tucked into the body, much like the limbs." Facial appliances were foam latex, while torso and limbs were translucent silicone, painted by Tim Gore.

In addition to Edwards, Pearl required a team of operators that included one puppeteer for each arm and another for the feet. Yet another was tasked with making the creature breathe. "Using a huge bellows," explained Teves, "our breath performer inflated several air bladders beneath the stomach and chest areas, which gave Pearl an eerie breath ing motion. Though the puppet was essentially immobile, Roland Blancaflor created an armature beneath its upper torso that shifted and swayed as the breathing motion occurred. It was just enough movement to keep Pearl from being dead static." In postproduction, additional movement was incor porated digitally by Post Logic, a hitherto video-oriented facility stepping up for the first time to create effects for a feature film.

Cannom Creations and Post Logic also collab orated on a scene in which Dragonetti (Udo Kier), lord of the vampires' governing body, is murdered by Frost and his minions. "Dragonetti's death is a graphic one in which Frost kidnaps the vampire overlord and drags him out onto a beach to witness his first and last sunrise," Norrington related. "He burns up and falls apart in a very detailed effect, yet it doesn't happen in just one shot; it happens over a period of three or four progressive disinte gration shots. First Dragonetti splits open and his skin melts away, unveiling a skeleton that bursts into flames and crumbles, finally exploding and drifting away as airborne ash."

Cannom Creations provided a three-stage pros thetic makeup for the actor, as well as two stages of burning puppets to achieve the effect. "We began with a very subtle makeup," said Keith VanderLaan, "and then we went to these progressive stages of makeup. Finally, we moved on to a puppet, just to take the effect beyond what could be done to an actor. There was also a final, second-stage puppet that was pretty much just a skeletal form with a melting surface." Bluescreen shots of the actor in makeup and the puppets were then blended into one continuous sequence by Post Logic 2-D artist Michael Killen. "Michael did a fantastic job of fixing discrepancies between the elements," commented Justice, "pulling off multiple 'micromorphs,' adding motion to totally static puppet effects and hand-painting chunks of burning flesh."

Called in to spell Cannom Creations and pro vide on-the-spot makeup effects was Image Animation International, headed by Gary Tunnicliffe. Tunni cliffe had been friends with Norrington for years and had worked with him on several past projects. "Whenever a little gag came along that Cannom Creations didn't want or that Stephen needed to turn around very quickly, he would give us a call," Tunnicliffe remarked. "We started off making light weight bodies of the Karen character for Wesley

Snipes to carry, complete with loose limbs and cor rectly articulated tendon structures to give them a lifelike appearance. I knew our work was convinc ing when, one particular shooting day, I was walking to the set with the dummy of N'Bushe Wright in my arms and several crew members ran up to me and asked if she was all right."

Image Animation's work was showcased during a sequence in which two of Frost's hitmen are dis patched in strikingly gory fashion. "Karen is a phy si cian specializing in blood and the human vascular system," stated Justice, "and she furnishes *Blade* with an anticoagulant called *E.T*A that causes vam pires to go into anaphylactic shock, halting their nervous and respiratory functions while simultan eously causing them to have an extreme allergic reaction. The biological response is so powerful, in fact, that the vampires swell to grotesque proportions and literally explode."

During the sequence, *Blade* stabs several crea tures with dartlike vials filled with the lethal *E.T*A, causing the vampires to go through the frightening transformation. "Stephen wanted a group of vam pire heads that would go through that transition," stated Tunnicliffe, "from human-looking to a very extreme effect." To facilitate the transition, three progressively swollen puppet heads were built for each vampire victim. Tunnicliffe and Mike Regan created the horribly deformed creatures out of pli able, plasticized silicone. "The first head was very light, but the larger second- and third-stage heads were quite heavy. All were required to perform the same movements, which were basically jarring left-to-right motions." Each of the heads was equipped with a motion control mechanism to actuate the moves, enabling them to be filmed separately, then digitally manipulated into a single composite shot by Digiscope. "We created reference points on the sculpts themselves, using the vampire's eyes and protruding canines so that they could be lined up in the computer for each transformation." On the set, the heads were detonated by John Hartigan to create the final stage of the allergic reaction.

"Late in the show," recalled Justice, "Gary and his team were again called in to generate essential elements for the reconceived finale in which Frost is killed quite graphically with not one, but five *E.T*A injections in rapid succession." To create the gelatinous expanding effect on Frost, Tunnicliffe and crew built a first-stage air bladder and pros thetic makeup for Stephen Dorff, a second-stage full-body puppet and a third-stage expanding Frost to depict the character at his most grotesque. All three stages were shot separately under motion control, then morphed into a continuous scene by Digiscope. "That scene was in the neighborhood of fifteen seconds long," remarked Digiscope com positing supervisor Grady Cofer. "So it was a very long morph."

"Getting all of the plates, Stephen Dorff, the in flatable bladders and the body sculptures to morph in one fluid motion took three weeks of intensive work," elaborated Dion Hatch. "Stephen supplied us with an Avid mockup of the whole effect; then Doug Sayre worked round the clock, breaking down each element into hundreds of tracking shapes in Elastic Reality. The shapes were set into priority groups and timed to morph at specific points dur ing the motion control move. We wanted to hang on to specific areas, such as Stephen Dorff's arm, to get as much real body motion as possible."

The last stage of the morph was intended to feature an on-set detonation of the life-size mock up, executed by Hartigan's special effects team. The sculpture was rigged with primacord, heavily inter woven throughout the latex skin. Attached to the back of the sculpture were nine one-gallon blood bags, each containing a charge–all of which were detonated simultaneously. *Unfortunately*, the practical blast only managed to destroy about a third of the bloated Frost figure–an unsatisfactory result in the minds of all. A contingency plan was imme diately set into motion, with Image Animation cre at ing a pair of twenty-two-inch-tall wax replicas to be likewise detonated and the resulting obliter ation in serted digit ally into the live-action temple back ground. "With a turnaround time of only three days," Tunnicliffe noted, "we set to work at once, sculpting the figures in just twelve hours, molding them with silicone and cast ing them in a device called a 'spinner.' The spinner utilizes centrifugal force to create a completely flaw less surface for a sculpture as it sets evenly in the mold. Our figures were cast in quarter-inch thickness and painted to match their lifesize counterparts." The miniature 'expando-Frosts' were then rigged with pancake primer charges–disks made of flattened, tightly-wound primacord–and pho tographed at high speed in two takes.

In the end, nearly a dozen visual effects houses worked closely alongside Stephen Norrington to

Gary Tunnicliffe–owner of Image Animation International–works on a set of vampire fangs.

adorn *Blade* with almost every conceivable form of movie wizardry. “The nature of these effects is such an untamable sort of discipline,” said Norrington, “all you can do as a filmmaker is put parameters on your resources and allow the people doing your effects to create within those parame ters. We are at a point now where we can literally manipulate the context of a film to a degree that we couldn’t have done only five or ten years ago, because we were locked in a film-frame mindset. Now, because we can create and adjust things digitally and photo realistically, the technology allows us to refine our stories with a lot more freedom. It also puts us at its mercy artistically, technically and financially –but that’s a whole other can of worms…”

Frodeman Frost’s demise—brought about by an anticoagulant injection that causes vampires to bloat until they explode–IAI crew members Bill Zahn and Brian Wade sculpt a life-size figure.

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DR. DOLITTLE
ANIMALS WITH ATTITUDE

ARTICLE BY *ESTELLE SHAY*

In the pantheon of children's literature, high on the list of favorites are the *Doctor Dolittle* stories, penned more than half a century ago by the English author Hugh Lofting. A veterinarian with the uncanny ability to talk to the animals, Dolittle and his menagerie of whimsical creatures gained even wider notoriety when Twentieth Century Fox adapted the stories for the big screen in a 1967 children's musical, with Rex Harrison in the title role. Some thirty years later–encouraged by the enormous success of *Babe*, the Australian import that paved the way for the current onslaught of talking animals–Fox would resurrect the character for Dr. Dolittle, a contemporized version of the original, directed by Betty Thomas and starring Eddie Murphy as the physician with the gift of animal gab.

Taking ample liberties with its source material, the nineties retelling revolves around successful surgeon John Dolittle, who, on the eve of negotiating a lucrative financial deal involving his medical clinic and an unscrupulous HMO, bangs his head on his car windshield while braking to avoid a stray dog. The knock on the head restores Dr. Dolittle's ability, dormant since childhood, to communicate with animals; and soon, to his utter dismay, he is conversing with Lucky, the stray–who has wormed his way into the Dolittle household–and Rodney, daughter Maya's wisecracking guinea pig. When word spreads among the local wildlife, Dolittle's home is suddenly inundated with critters seeking medical consult, and his well-ordered household is thrown into disarray. Eventually, the doctor's reluctant animal ministering–which runs the gamut from a sobriety test on a drunken monkey to brain surgery on a suicidal tiger–opens both his ears and eyes to the real rewards of doctoring.

For the talking-animal movie, Dr. Dolittle, animatronic puppets by Jim Henson's Creature Shop were used for scenes deemed too difficult to achieve with live trained animals.

With initial plans calling for more than a hun dred talking-animal shots–a number that would eventually triple–it was evident from the outset that Dr. Dolittle represented no small endeavor. Thomas–new to effects filmmaking–planned to accomplish the effects in the Babe mode, through a combination of real animal performances, manipulated digitally in postproduction to effect the illusion of speech, and animatronic puppets on the live-action set. Hired to guide the training and on-set work of the cast's huge, nonhuman contingent was noted animal trainer Mark Forbes, while ani matronics were commissioned from Jim Henson's Creature Shop in *Los Angeles*. Enlisted to supervise the visual effects was Jon Farhat–whose previous outing on *The Nutty Professor*, another Murphy caper, had earned him a reputation for doing off-the-cuff, character-based effects. Farhat's proven methods of working with motion control and split-screen

photography, plus his prior collaboration with Murphy, clearly gave him an edge. “I promised Betty that I would handle all the technical stuff on set,” recalled Farhat of his initial meeting with the director, “allowing her to improvise and be free to concentrate on her actors.” Farhat would end up splitting what proved to be a sizable digital work load between a number of effects houses–chief among them VisionArt Design & Animation, POP Film, C.O.R.E. Digital Pictures and Banned From the Ranch Entertainment. Other contributors included Cinesite, Pacific Title/Mirage Digital and Computer Film Company.

Work on the animatronics, under Creature Shop visual supervisor Peter Brooke, began in October 1996, well before the start of princi pal photography. Key among the puppet constructs were replicas of the dog Lucky and the ailing tiger. Rather than create one puppet for each, Brooke and his team opted to build multiple specialized versions in varying poses. Three Luckys were made–one in a sphinx-like seated position, another in a crouched stance for a scene in a vet’s office, and the third as a walk ing rig designed to be shot from the chest up. Also sculpted were two fully mechanical tiger heads and two full-size versions of the tiger–one sitting up, which could be repositioned in a lying-down pose; the other a full-body, standing version. Other ani mal characters built by the Henson crew included two versions of Rodney the guinea pig, three ver sions each of a comedic rat duo who pop up at var ious times to comment on the action, and a pair of bickering pigeons who seek out the good doctor for couples counseling.

Visual effects supervisor Jon Farhat enlisted a number of digital houses to produce talking-animal shots. POP Film used 2-D animation and split-screen work for scenes in which Lucky the dog converses with Dolittle (Eddie Murphy).

Mechanics for the animatronic animal heads were designed by lead mechanic Michael Scanlan. “Mike took a creative approach to the mechanics,” commented Brooke. “There’s a tendency to look in the mirror to see how a human mouth moves dur ing speech, and impose those human lip shapes onto our animals. But Mike felt it would be better to take the animals’ real lip con figurations and try to keep them intact as much as possible, while still allowing the mouth to move in a way that formed the right shapes and suggested speech.”

Visual effects supervisor Jon Farhat enlisted a number of digital houses to produce talking-animal shots. POP Film used 2-D animation and split-screen work for scenes in which Lucky the dog converses with Dolittle (Eddie Murphy).

With a script that was clearly still in flux, film-ing for Dr. Dolittle began in March 1997. Logistics were anything but simple, considering that the cast included more than a hun dred per forming animals and birds. When it came to filming effects scenes, it fell to Jon Farhat and Mark Forbes to bring order to chaos on the live-action set. Working with live animals frequently meant that Farhat had to rely on split-screens for scenes involving Murphy and his creature costars. “Obviously, we couldn’t film Eddie with the tiger,” stated Farhat, “but there were also lots of other shots where we had to capture sepa rate elements because of performance issues. Eddie was unavailable, or the dog required some big vocal command to get it to do something–which you couldn’t do with the actor in the scene.”

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On set, Farhat relied on the same techniques he had employed successfully on *The Nutty Professor*. “Whenever Betty was shooting something that had to do with effects, I had a motion control unit and video assist standing by. It was all motion tracking cameras and digital video–probably one of the most elaborate systems ever used–and it was the heartbeat of the set. Everything ran through it. Video assist generated the time code, and we had just one time code for everything–camera, sound, motion control–it was all in sync. We could get in, shoot a motion control setup and get out in the time it took first unit to set up a shot. We did 750 motion control setups on this show, with about fifteen to forty-five minutes warning for each.”

To ensure that eye-lines between Murphy and the animals were perfectly in sync, especially dur ing dialogue scenes, filming the separate elements for the split-screens required an approach similar to the one Farhat had employed for *The Nutty Professor*, where Murphy was called upon to play opposite himself. “In this case, if we were shooting a scene where Eddie was proactive and the animal had to react, we’d shoot Eddie first so that we could work the animal to what he did. Then, if

we put the trainer exactly where Eddie was in the scene–and the animal's eye was specifically locked onto the trainer's–when the two sides of the shot were as sembled, the animal would appear to be looking directly at Eddie." Conversely, if the animal had the principal action and was photographed first, Farhat would track its moves, then rig a tennis ball to hang in space–precisely where the animal's eyes had been–for the other side of the shot, with Murphy. "To move the ball, we used a motion control motor. With a cable-and-pulley system erected along the animal's path, I could run the tennis ball on a wire so that wherever the animal's head had been, we could rig the ball to move in precisely that path. Then all I had to do was say: 'Okay, Eddie. Imagine that the tennis ball is the tiger's head. As long as you're looking at it, you'll be perfectly synced.'"

The animatronic animals–operated by a team of six Henson puppeteers–were reserved for scenes where it was either impossible or impru dent to film with the real animals. For puppet shots of Lucky, including one in a vet's office where the unhappy dog under goes a rectal examination, Bill Baretta operated the character–hand-puppet-style–from within. Facial functions and lip sync were controlled externally, by lead puppeteer Allan Trautman, via the Henson Performance Control System. Additional movements, such as tail wagging or breathing, were achieved by another operator stationed beneath the set.

Articulation of an animatronic Rodney in his cage was accomplished with an array of ser vos con cealed in the bottom of the cage and operated via radio control. "Eddie Murphy could pick up the cage with the talking guinea pig in it, and con tinue to move about," said Brooke. Other puppet segments included the bickering pigeon episode, another in which a choking rat is revived through CPR and a sequence involving the tiger–anesthe tized but still conscious–undergoing surgery.

Although an estimated seventy-five to one hun dred animatronic shots would make it into the final cut of the film, the practical approach proved limit ing at times, due to exigencies of shooting without a firm script in place. "Early on, we had ascertained what we were going to build," noted Brooke, "and we had a substantial storyboard to work from. The problem was it changed all the time. Betty wanted something that was completely versatile–but we didn't have that. Based on the storyboard–which was thrown out the window from day one–we had nailed down, at the outset, what we were building, how we were going to build it, and how many ver sions we would need. That worked to our disadvan tage because then we were stuck with it. If we had a seated dog that was operated from underneath, and suddenly Betty wanted to put it on a San Fran cisco street, we were screwed. Jon, on the other hand, could fly with the punches."

During production, Farhat had often expressed reser vations about the use of animatronics in the picture–even animatronics enhanced with digital effects. In fact, his concerns were so strong that during effects shooting he would frequently hedge his bets by filming the animatronics with motion control, then capture clean plates in the event the puppets had to be replaced. Determined to rely as much as possible on the real animal performances, Farhat hit upon a strategy for digitally engineered lip syncing that would rely on 2-D manipulation of live plate photography, rather than the more time-consuming and costly 3-D techniques which had become the standard in movies such as *Babe*.

"When I first started experimenting with 2-D during preproduction," Farhat recalled, "everyone insisted that a 2-D approach had been tried with the dogs in *Babe*, and it hadn't worked. But I said:

‘Historically, we’ve all been trying to open an ani mal’s mouth. Why don’t we try closing it? It’s easier to close a mouth than it is to open one.’ So I asked Mark Forbes if he could train our star dog Sam to open and close his mouth on cue, based solely on hand signals. That had never been tried before. I don’t know how he did it, but he went off and came back in about two weeks with Sam trained.” The resulting talk cycles–alternating close-open-close mouth positions captured in the plate photography–enabled digital artists to create a palette of 2-D mouth movements that they could then speed up or slow down, widen or close, and, through a sort of cut-and-paste animation technique, match the movements to the recorded dialogue. Although the 2-D approach ended up being used in only half of the talking-animal shots, it was always the method of choice.

One of the first digital effects houses to attempt this approach was POP Film. As early as May 1997, the facility had begun working closely with Farhat to conduct 2-D tests on footage of a real guinea pig. “Jon wanted to do the movie in a way that was 2-D oriented to keep the integrity and resolution of the animal performances,” recalled Melissa Brock man, who co-produced POP’s visual effects with Mark Brown. “He believed he could make the actual animals talk by simulating movement in 2-D, rather than putting 3-D mouths on them. It’s similar to 2-D cel animation–no pencil or paper, but you’re manipulating a piece of film, frame by frame.”

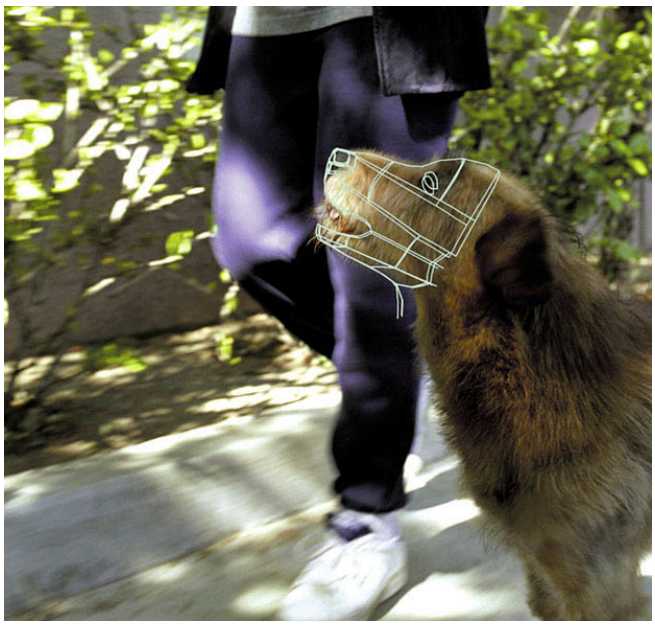
The tests proved successful, and POP’s assign-ment grew over the ensuing months to encompass fifty-nine talking-animal shots, three-quarters of them consisting of 2-D animation on Rodney and Lucky. “The advantage of concentrating on just one or two animals,” noted Brockman, “was that, performance-wise, we could get a better idea of what the director was looking for. Also, there was a definite learning curve. When we started, it was difficult and the shots took much longer; but once we figured out what worked and what didn’t, we hit our stride and everything speeded up.”

Outfitting their Inferno with a custom board to sync the audio to the plate photography and con vert the soundtrack to a visual readout, composit ing supervisor and lead animator Jennifer German, together with fellow animator Kelly Granite, began by studying the recorded dialogue. “We’d listen to it over and over and write down where the open and close points of the pronounced syllables were,” stated German. “Getting just the right amount of movement took practice. I found that if I hit my points too much, the speech would appear too pronounced. So I would find the strongest points, then pull back.”

To achieve the 2-D facial animation, German would take sections of the real image and do edits and warping and tracking to get the appropriate mouth movements. While talk cycles captured in the plate photography proved useful for some shots, German later perfected a method that gave her more control over the results. “Instead of using the talk cycles, I’d take a still frame of the mouth in an open position and physically move it in a 2-D arena over the original image. The cycles were help ful, though. I used them to study how an ani mal looked when it was opening and closing its mouth, and that gave me a reference as to how to simulate muscle movement in the face.” Animated pieces were blended into the real animal’s face in multiple layers of movement, like layers of muscle. “We’d start off getting the big up-and-down motion of the open mouth, then do side moves, building from forward to back. It was almost like painting with movement.” In addition to the mouth work, which sometimes included painting in tongue and teeth, other areas of the face were manipulated to convey expression. “We’d discuss each shot to try and get at the emotional

core of the character. A lot of expression was achieved in the corners of the mouth or the cheeks, or by moving the eyes and eyebrows up and down."

When it became apparent that certain Lucky scenes could not be done effectively with a strict 2-D approach, a different strategy was employed. "If we had talk cycles, we'd do it 2-D," Farhat noted, "but it wasn't always possible to get talk cycles. To get an animal opening and closing his mouth, he had to be looking at his trainer; he couldn't be do ing another behavior, like walking or jump ing up." Other difficulties arose with shots that had major perspec tive shifts or complicated camera moves. To overcome these obstacles, Farhat reluctantly turned to 3-D computer animation, requiring that a highly accurate three-dimensional model of a muzzle or beak or an entire head be animated and blended onto the real animal, then tracked into the shot. "I had reservations about getting into 3-D because I'd never really seen it done successfully with living characters. We didn't want overanimation. We wanted very subtle, precise movements–like our animals were impeccably trained."



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VisionArt visual effects supervisor Joshua Rose and a crew of eighteen would end up taking a major slice of the digital pie, applying a 3-D approach in combination with 2-D techniques to some seventy shots. “The bulk of our work was thirty or forty 3-D Lucky shots,” stated Rose, “but we also had some Rodney shots, some pigeon shots, an orangu tan sequence and one or two shots of everything from talking goats and sheep to a raccoon, a pen guin and a pig. Fortunately, we got very good at tak ing our 3-D models and modifying them. We could take the dog’s mouth, for example, and modify it to be a possum’s or a raccoon’s, then just apply a new texture.”

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VisionArt first exercised its 3-D muscles on a sequence in which Dolittle visits a vet’s office with Lucky in tow. There he hears the comical protestations of a German shepherd about to be neutered. “John knew it couldn’t be done 2-D because they couldn’t get talk cycles on the shepherd,” related Rose. “Also there was a major perspective shift on his face. So it was kind of a test case for us.”

Having successfully passed the test, VisionArt began addressing other problem shots, working pri marily in Prisms for modeling, animation, lighting and rendering, with some proprietary plug-ins to help with speech animation and other spe cialized tasks such as motion blur. Digital artists, under 3-D animation supervisor Stirling Duguid, started by constructing a 3-D model of select portions of the animal’s face. “In the majority of shots, we were modeling the entire mouth or muzzle area,” stated Rose, “sometimes going even further, into the eyes and the top of the head. In other cases, it would be only the lower jaw, or lower jaw and half of the upper jaw. It varied depending on what was needed on a shot-by-shot basis, but the goal was always to use as much of the live-action plate as possible.” In addition to the exterior mouth, digital artists procedurally built, as needed, the inside of the mouth, including throat, tongue and teeth.

Animating the 3-D models to effect the illusion of speech followed the form of traditional 2-D ani mation, with a series of mouth positions built up according to consonants and vowels. “We would go through the prerecorded dialogue, and choose which mouth shapes to hit at which moments,” ex plained Rose, “and the computer would then blend be tween them based on the percentages we called out.” Once the 3-D model of the mouth or muzzle was lit and rendered to match the live-action scene, it was up to the 2-D animation team, overseen by Ted Fay, to integrate it into the live-action animal, stabilizing background plates and feathering edges to create a seamless blend. The 2-D crew would also add secondary animation such as eye expression or moving whiskers.

Tracking of VisionArt’s computer effects to the real animal in the plate photography was achieved using special 3-D and 2-D camera tracking software devised by the company’s R & D department.

“When we had no information–just a plate–we used the 2-D tracker,” explained Rose. “In as few as five key-frames on a whole shot, it could immediately lock the 3-D mouth to the live animal by correlating the movement of certain shapes defined and given key- frames in the plate. That tracking information was then plugged into Prisms to become the camera with which the mouth was rendered.”

An opening flashback scene in which Dolittle's childhood pet–a border collie named *Old Scratch*–is seen imparting words of doggy wisdom to his young master would include an extreme closeup shot of the talking dog that presented the VisionArt team with one of its thorniest challenges. "That was the shot from hell," remarked Stirling Duguid. "Definitely our hardest. It was also the first talking-animal shot, so it had to sell the film." Working on the sequence for nearly nine weeks, animators initially approached it from a purely 2-D standpoint, pushing that technique as far as it could go. Dissatisfied with the results, they subsequently tried a full 3-D approach, creating a 3-D mouth geometry. That, too, revealed problems and mistakes. Even tually they settled on a hybrid strategy that com bined both 2-D and 3-D processes. "The upper jaw and upper lip animation ended up being 3-D," said Rose. "The lower jaw opening and closing and lip animation and cycles were all manipulated in 2-D. Then we added in a 3-D tongue flapping in the back of the mouth to help enunciate some of the words without going overboard on the corners of the mouth and lips. The movement of the fur and jowls that resulted from the opening and closing of the mouth was sympathetically animated in 2-D, driven from the motion of the 3-D. It was one of our most intense Cineon comping jobs because of the blend ing in of 3-D whiskers and the overlapping of 3-D mattes and 2-D elements."

Another complex lip sync was needed for an orangutan, featured in a brief sequence in a psychiatric facility where Dolittle is sent for observation. Given the opportunity to prove that his unusual talents are no figment of the imagination, Dolittle tries but fails to communicate with the simian, discovering too late that it speaks only Spanish. Digital artists recreated the orangutan's mouth as a 3-D geometry, replicating the flesh-tone area around the lips and using the point at which it fades into the surrounding dark fur as the blend line. "Production had shot it for a 2-D approach, and we actually had some talk cycles," remarked Duguid, "but the orang utan was doing crazy, funny things with his lips–like turning them practically inside out–which would have taken too much modification." With his highly malleable mouth and expressive face, however, the ape provided an ideal can vas for com ical expression. "Ted Fay did a wonderful job on the eyes," observed Rose, "which were animated in 2-D using Elastic Reality, opening and closing them so you got that Cheech Marin aspect."

Rats shot as separate bluescreen elements were composited together by C.O.R.E. Digital Pictures and made to speak via 3-D snout replacement.

A 3-D approach was also used for a dozen shots of a talking owl. C.O.R.E. Digital Pictures, based in Toronto, was recruited to handle the work. "I believe Jon Farhat came to us because we had done all of the digital geese for *Fly Away Home*," commented John Mariella, who served as co-animation director with partner Bob Munroe. "He figured if someone could do geese, then owls weren't too far away." Working in Houdini, a team of fourteen animators, led by technical directors Brian Smeets and Dave Willows, began by replacing ninety percent of the real bird's head in 3-D. One of the trickiest aspects of the work was seamlessly integrating the CG part of the head with the rest of the creature. "There was no easy edge to cut and say, 'This is CG and that's real.' In one instance, the real owl's head in the plate was looking out front toward the trainer, but Betty and Jon wanted it to turn and look toward a twig stuck in its wing. So we had to contend with the way an owl's feathers overlap when its head turns, and find a way to get our geometry to move like that."

Rats shot as separate bluescreen elements were composited together by C.O.R.E. Digital Pictures and made to speak via 3-D snout replacement.

Another thirty shots, featuring a pair of comi- cal rats that pop up periodically to offer snide com men tary, were also assigned to C.O.R.E. Originally done using animatronics, Farhat had been unhappy with the results and fought to have them replaced. "I knew that the only way to get them fixed was to shoot them properly with real animals," Farhat recalled, "so I found the money to do that. We shot rats that were trained to stand up and look to eye lines. We needed to shoot high-speed to slow them down because they wouldn't stay still. It took a lot of light to get a workable focus range. While we were shooting, C.O.R.E modeled the rats' heads and shoulders in CG. Once the footage was cut, they removed the real heads by painting to clean back grounds, then replaced them with their animated CG heads. It was perfect."

Four talking rat shots were needed quickly for the theatrical trailer. "We only had three weeks, so we really had to gun it," recalled Mariella. "While everyone else was working on the owls, Berj Banna yan–head of our R & D department–and I came up with a way to animate the rat's fur. We basically wrote plug-ins for Houdini that would take our ani mated geometry on a 'shaved' rat and–given our barbering parameters–automatically generate fur on the surface, which would then be rendered with RenderMan." Another R&D recruit, Moris Molino, was

instrumental in setting up the rat geometry and generating a library of predefined lip syncing that animators could essentially plug and play. "Initially, we were overcompensating–replacing the entire shoulders, neck and head of the real rats with CG versions, because we figured the director would want a little more characterization and ani mation in the performances. So there are two shots in the trailer where we did that. But when it became clear that Betty wanted as much of the real rat in there as possible, we scaled back. For the remain ing shots we did mostly 3-D snout replacements, staying just below the eyes."

Among shots done by Banned From the Ranch were those involving 2-D animation of a live tiger that was photographed in a cage, then extracted and composited with footage of Eddie Murphy emoting to a tennis ball for proper eye-line.

As did all the digital effects providers, C.O.R.E. found itself grappling with extraneous animal ac tiv ity in the plate photography. "The way the train ers got the rats to stay still was by stuffing food in their mouths," remarked Mariella. "So any footage we received was basically a rat eating. Once we had our CG snouts in place, any trace of the chewing that was still evident had to be removed." In some instances, digital artists–under 2-D ani mation director Tracey Vaz–used Elastic Reality to erase the chewing by morphing from closed mouth to closed mouth, skipping the open positions.

One of the last facilities to join the postpro duction team, after principal photography on Dr. Dolittle had wrapped, was Banned From the Ranch. Given responsibility for forty-six shots, including several of a dancing guinea pig, a brief segment with Dolittle and an inebriated monkey, and nearly all of the tiger shots, the artists at BFTR were eager to make their first move into character animation. "Jon's idea of having just one house be the primary 'actor' for an animal made a lot of sense," stated BFTR co-founder and visual effects supervisor Van Ling, "because after a while you get a feel for how that character talks and behaves. In the case of the tiger, we were dealing with a really complex series of emotions. When Dolittle is first summoned to his aid, the tiger has escaped from a visiting circus and is perched on the balcony ledge of the Coit Tower in *San Francisco*, preparing to jump. He's blustery and making jokes, but at the same time calling out for help. That was one of our primary scenes, and we had to get all of that into the performance."

In addition to performance issues, the tiger shots presented all manner of practical problems. "When you're working with animals, you're dealing with a lot of variables," noted Ling. "And although Betty and Jon took great pains to ensure that we got usable elements, there was still a lot of clean-up work that had to be done before we could even address the animation. For obvious safety reasons, the tiger was on a leash almost all the time–which had to be removed. And like most cats, tigers are easily bored and have very short attention spans. So to get their attention on set, the trainers would be waving sticks with meat on them or squirting milk at them, which they liked." Even more time-consuming than leash removal, trainer removal or milk removal, however, was the call for tongue removal. "This animal had an amazingly prehensile tongue, and it loved to lick its face. We had a tongue 'hall of fame'–frames of all kinds of unbelievable things the tiger was doing with his tongue. In some shots, it actually flapped up over his nose, around his face and under his chin. So there was a lot of paint work to remove it, which we did using a pro gram from Puffin Designs called Commotion."

The BFTR team–under lead artist Erich Ippen –did all of its animation on Macintosh computers, using Adobe AfterEffects as its primary tool. "All of the other houses had SGIs or Infernos," related

Ling, “but we’re big Mac fans, and we really wanted to prove that you could use them for character ani mation. We took an off-the-shelf package–known for broadcast graphics, flying logos and stuff like that–and said: ‘You know what? This is not about tools and technology. It’s about talent and getting through the technology to the performance.’” The emphasis on performance would also be a factor in BFTR’s decision to approach the animation strictly from a 2-D perspective. “We figured why recreate something in 3-D and have to make it look real if you can use what you have in the actual plate? You spend all your time making the 3-D jaw just right, as opposed to creating a performance.”

The 2-D approach would require some clever solutions to difficult shots–particularly ones with the tiger, for which there were no live-action talk cycles. “We were using the chin that was already there in the shot and just painting out the inside,” stated Ling. “The tough parts were when the tiger turned its head a lot, but still had to be talking and emoting. Then we would have to fade between stills every couple of frames, and it was a lot of work painting the chins and tracking them in so that we had a clean one to work with.”

In addition to manipulating the 2-D jaw, BFTR animators incorporated additional facial animation to lend depth to the performances. “We really went to town on the eyes, crinkling them and rais ing the brows and doing all those kinds of things that were important to give it character. One of the things Jon said to us at the outset was: ‘Just getting the lip sync right is only part of it. The other is to make it feel like the character is actually saying the words.’ A lot of that comes out of the eyes and whatever the character is doing with his face to go along with the dialogue. In some cases we did body animation, too. We would alter how the tiger was moving, physically make him lift his head–things that weren’t in the plate, in order to help create that illusion of a performance.”

Three shots of Rodney singing and dancing in the best tradition of *Saturday Night Fever* were cleverly achieved by shooting the real guinea pig with its front paws clasping a rod. Animal trainers hoisted the creature into an upright position and moved the rod back and forth to create appropriate paw and body movements. “Of course, the rod went through his fur and up under his neck,” said Ling, “So the real labor-intensive part was just trying to paint out any traces of the rod and its effect on the fur.” Erich Ippen then animated Rodney’s singing and added a few enhancements, such as foreground shadows, 3-D animated paws pointing and some head bobbing and tilting.

For a comical episode in which Dolittle admin isters a sobriety test to a decidedly tipsy monkey, BFTR lip-synced the live character to the heavily French-accented vocalizations of actor Phil Proctor. Ippen then added body movement to go along with a hiccup that accompanied a fortuitous shot of the real monkey pursing its lips. The final composite also included Lucky, plus two background penguins and a pig. “We had no bluescreen element of the monkey,” noted Ling, “since he and Eddie Murphy were filmed together in the scene. So we had to roto him out in order to put the other animals in behind him.”

Throughout postproduction, scanning, color timing and compositing of effects shots were criti cal issues. Farhat turned to Cinesite for all of his scanning and recording, relying on the company to handle most of the straight compositing work as well. Under the guidance of digital effects super visor Thomas Smith, Cinesite was also instrumen-tal in completing numerous fix-it shots and doing some digital sweetening. “I owe Tom a tremendous debt of gratitude,” stated Farhat. “His little group just did incredible work. Beautiful comps and fix-its. Almost every problem color shot that

came in I would give to Tom and he would balance every thing. He provided quality control for all the facil ities' shots. They knew they could send their stuff to Cinesite for a final dial-in. It freed them up to concentrate on just the animation."

After all was said and done–after the script problems were finally hammered out, the frustrations of working with live animals long forgotten and the last postproduction nightmare shot in the can–Jon Farhat could finally take a breath and look back on his two-year involvement making Dr. Dolittle with both relief and satisfaction. "This was probably one of the most difficult shows Fox has ever done," Farhat reflected, "and I think it turned out incredibly well. That is owing in no small part to the fact that the animals in this movie aren't just talking mouths. They are comically expressive characters. Eddie Murphy is the straight man and they're the ones with the attitude."

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THE TRUMAN SHOW
THE UNREAL WORLD

ARTICLE BY KEVIN H. MARTIN

The Truman Show straddles two worlds. In one –the film's fictitious reality–it is a top-rated television show, while in our real world, it exists as a major motion picture release from Paramount. In both realms, it traces the life of Truman Burbank (Jim Carrey), an insurance agent living and working on idyllic Seahaven Island. Truman's world seems too perfect to be real–and is, in fact, a construct, eventually revealed to be the world's largest television studio, contained within a three-and-a-half-mile-across dome covering the Burbank hills. To maintain the illusion of reality for Truman, the fictional television series required a range of splashy, elaborately staged effects; but to do the same for director Peter Weir entailed more subtle sleight- of-hand, utilizing nearly subliminal effects that worked as much on the audiences' subconscious as it did their eyes.

The film's screenplay, penned by Andrew Niccol, built on the last decade's explosion of reality-based programming. This trend was inspired in large part by a series of British films–14-Up, 21-Up, 28-Up and 35-Up–documentaries by Michael Apted that chronicled the lives of designated English subjects at seven-year intervals. In the U.S., MTV devised The Real World, a popular series following the lives of culturally diverse twenty-somethings brought in to live together for months at a time under multi-camera scrutiny. The Truman script, written long before Niccol turned director with Gattaca, actually presaged the true-life case of Jennifer, a young American woman who has spent the last two years televising virtually every aspect of her life over the Internet. Her activities, monitored by thousands of web crawlers, spawned a flock of copycats–people intent on claiming their fifteen minutes of fame by broadcasting their own unrehearsed lives out to voyeuristic masses.

The Truman Show's protagonist differs from these real-world counterparts in one important way– Truman Burbank remains blissfully unaware that he is on television, and that he has always been on television. Adopted at birth by the Omnicom television network, Truman's whole life has played out on television screens the world over, to increasingly high ratings. Due to mounting inconsistencies in his 'staged' environment, Truman grows suspicious of everything and everyone around him. He makes repeated attempts to leave this mink-lined prison, only to be thwarted in these efforts by Christof (Ed Harris), the all-controlling producer responsible for Truman's circumstances. Peter Weir's vision of Truman's world called for subtle visual embellishments–many taking the form of near-subliminal cues–that hinted at Seahaven's true nature without making the town appear as an obvious and outright fabrication.

In The Truman Show, Jim Carrey plays Truman Burbank, the unwitting subject of an insidious reality-based TV show. Visual effects for the Peter Weir film were supervised by Micheal McAlister.

Some of these subtle illusions would be engineered on stage, while others would fall to visual effects supervisor Micheal J. McAlister.

McAlister had worked previously with Truman production designer Dennis Gassner on *The Hudsucker Proxy* and *Waterworld*. “Dennis was instrumental in getting me onto the project early,” said McAlister. “With our successful past collaborations, we’d established a rapport with one another, and were able to accomplish some good work up front, eliminating elements that weren’t really valid for this story.” Conceptual input on the visual effects also came from cinematographer Peter Biziou and the film’s director. “Peter Weir was not usually inclined to go for the ‘big image’ if it would only be used for sheer entertainment or shock value. However, Peter would use one to convey a significant story point; and this measured approach to visual storytelling led to the trimming of many effects from the script before shooting. If big dramatic shots related to Truman’s character arc they remained; if not, they went away.”

McAlister selected Cinesite Hollywood and Computer Film Company to provide digital effects and handle compositing duties. Matte World Digital created a wide range of virtual vistas, while Peter Chesney’s Image Engineering fashioned a backlot storm of epic proportions. The teams worked principally from key-frame illustrations and CAD drawings–the latter proving especially useful for effects requiring set extensions. Since the cost of building Truman’s entire hometown on a backlot was prohibitive, the quest for a location to serve as Seahaven began. While location scouts scoured each coast, it was visual consultant Wendy Stites who discovered Seaside, finding a reference to it in an old architecture magazine. “It’s this strange little Florida town set on seventy-two acres,” McAlister related, “one of those idealized, planned communities. There are four hundred buildings with neo-Victorian archi tecture, painted in odd pastel tones. The place has a hyperreal, slightly Fantasyland look to it, with picket fences and green grass everywhere.”

After stabilizing and sharpening a helicopter plate of the Florida coastal community chosen to represent Truman’s fabricated hometown of Seahaven, Matte World Digital expanded the town, created a waterway around it and altered the horizon line and clouds.

McAlister directed second unit work while overseeing effects plate shoots taking place in Seaside. “We came to realize that while the town cried out to be photographed beneath clear blue skies during the day, it also looked particularly vibrant at dawn and dusk,” observed McAlister. “The pastel colors of the town seemed to glow under these lighting conditions. This was a huge factor in making the town look hyperreal.” In planning the plate shoot, McAlister faced a dilemma involving film formats. “We were going to be shooting from a helicopter with a Wescam gyro-stabilized rig. Going with Vista vision would ensure better images and sharpness, but meant we’d have just two minutes of film per load. The helicopter landing point was a ways off from where I’d be shooting; so landing, reloading and taking off again before the sun set would not be possible. I settled on regular 35mm to get more shooting time, figuring we could deal with sharpness issues later. I knew we could never achieve the special look of the town any time other than the few minutes before dark. The

lack of clarity drove us crazy for a bit, but Cinesite provided a sharpening algorithm that helped resolve the issue."

Weir and McAlister met with the Matte World Digital staff to devise a strategy for visualizing the distant vistas within Truman's world. "We needed matte paintings that looked slightly off," McAlister stated. "This was necessary to make a story point about the nature of Truman's surroundings, but they couldn't just look like bad matte paintings. It was a really fine line; and some shots required multiple iterations, because we had to come up with a credible but unique look. The first step was to foreshorten the horizon. In the real world, the horizon is about six to eight miles away, but in Truman's world the horizon was truncated about a half-mile out from shore. The horizon line was curved more tightly as well. This distorted horizon, coupled with an oversize moon, combined to create a feeling of things not quite right, and of a place that was just too pretty."

Views of the oversize moon were derived from stills of the real one, shot from a NASA space shuttle. "Since there's no atmosphere in space to reduce image sharpness," related McAlister, "those stills were perfect–a little too crisp, clear and contrasty, which made them slightly off in just the right way for Truman's world. Then, to make a zoom move on the image, we had to nest separate moons at different resolutions. If we hadn't replaced the original moon element, we'd have wound up with pixels three feet across. Even with a 4K image, after a certain point you've moved in so far it's down to 1K, necessitating a bump-up to another high-K image to continue the zoom. It took a lot of paint work and massaging to keep the resolution up and minimize creepy-crawly noise."

The concept for a larger-than-life moon came from 1940s vintage postcards of Florida supplied to Matte World by the production art department. "The postcards had big yellow moons pasted into a deep blue sky," said MWD visual effects supervisor Craig Barron. "They were made at a time when only three or four colors were used, and the colors were goosed up so much that everything began to look overly stylized. The cards did suggest an approach–maintaining a certain baseline level of reality in the foreground while adding these strange background elements. Later, when we worked on shots that established Seahaven, we retained some of the postcard look. This helped us keep things looking slightly off, as if parts of the scene were man-made interpretations of nature. We added aerial perspective and haze within the dome, but it had to be done sparingly in order to maintain the hard, curving horizon line at the dome's edge." To create cloud movement, digital matte artist Brett Northcutt enhanced real Florida clouds with digital paint and separated them into different layers. These clouds were moved in multiplane, then warped by digital composite supervisor Paul Rivera to conform with the interior curvature of the Seahaven dome.

A helicopter element for one of the film's establishing views of Seahaven lacked sharp detail–due to its having been shot in 35mm–and proved to be beyond the capabilities of Cinesite's sharpening filter algorithm. As a result, it became necessary for Northcutt to repaint the entire town using Amazon paint. One important story point–necessary to keep the water-wary Truman a prisoner in his own town–established Seahaven as an island. Since the actual location was partially landlocked, some cosmetic

alterations were in order. “To effect this transformation,” related chief digital matte artist Chris Evans, “we grabbed moving water from the ocean area of the plate and took it inland, creating an inlet isolating the town from the rest of the land mass. Brett built a bridge in the computer linking Seahaven with the mainland, then animated a car going across to give the scene some movement.”

To heighten single-story sets built for scenes taking place in the Seahaven business district, Matte World created 3-D digital set extensions aligned to live-action camera moves.

The film begins with Truman already showing signs of dissatisfaction with his lot in life, most especially with wife Meryl (Laura Linney), an actress-in-character and Christof-imposed control element responsible for quashing his dreams. Truman’s general ennui evolves into befuddlement and confusion when he witnesses a studio light falling out of the wide blue sky. Then, after his car radio picks up a strange voice transmission–one reporting on his movements–Truman encounters his long-lost father, another actor in his life’s drama, whom he saw perish in a staged boating accident as a child. But before he can speak, the man is whisked away. This series of strange events finally leads Truman to believe that his placid surroundings are not all they seem to be, proving the adage that you can’t fool all of the people all of the time. “Our perception of reality is subjective,” Evans observed, “and Truman wasn’t the only one fooled. It happened to me when Craig and I went down to the set to meet with Peter Weir. We wound up in Christof’s control room. I saw those consoles and thought we had made a wrong turn–that somehow we had gotten ourselves into the Paramount sound mixing room. It was a while before I realized this was the ‘lunar room’ set for the movie. Like Truman, I found myself trapped in an illusion within an illusion.”

For a contemplative scene between Truman and his friend Marlon, Computer Film Company replaced a neutral sky with a fiery sunset.

Breaking from his long-established routine, Truman enters an unfamiliar downtown building and finds a sort of ‘green room’ area within an ele vator compartment–an event firmly establishing for him that his world is a stage and many if not all of the men and women inhabiting it are players. Scenes taking place in the downtown area of Seahaven required a considerable degree of invention since Seaside lacked a suitable business district. “The production built office buildings for Truman’s workplace and other parts of downtown,” recalled Evans. “They constructed the first floor, then had us create the upper floors in the computer. Since production designer Dennis Gassner and his staff set up this whole section of town as a series of CAD drawings, we were able to utilize the very same computer models for our digital extensions that the art department used for construction.” Consequently, production was able to shoot the live-action with full freedom of camera movement, as Matte World Digital tracked in the CAD wire-frames, lining them up over the live-action buildings using 3D Studio Max and Softimage.

Working from stills of the production’s single-story buildings shot by Craig Barron, Evans–aided by Northcutt–created texture maps for the upper floors, refining the imagery via Adobe Photoshop and

Amazon Paint. Modeler Morgan Trotter applied the textures to wire-frames, then passed the elements on to Paul Rivera for compositing in *Alias*/ Wavefront Composer. The flexibility inherent in the CAD approach became manifestly clear when Weir elected to alter the height of the downtown structures. "Originally," Barron observed, "all of downtown was to be four stories tall. But at that height the buildings went right up out of the top of frame, so Peter asked us to cut many of them back to three stories. If we had done these as traditional matte paintings, it would have meant repainting whole scenes. If the buildings had been built full-size, it would have been a major paint-out problem–to say nothing of being very expensive and wasteful. But this method allowed us to segment out the unwanted level easily."

A troubled Truman ventures out to gaze into the night–one of several nocturnal vistas featuring an oversize moon and constricted horizon. "The background came from a daytime helicopter plate," Evans remarked. "We added a lighthouse and night sky, painted by artist Caroleen Green, then replaced the ocean with Areté night water, which helped tie the various elements into our digital matte-painted backgrounds. We designed the ocean element so it would appear to be very still and calm, reflecting Truman's contemplative mood." Since the standard package was dedicated to mimicking reality, Areté wrote a special version of their software to accommodate Truman's exaggerated-reality world. Other MWD embellishments reinforcing Seahaven's too-perfect nature included enhancing the town's blue skies and tracking a nicely manicured lawn over dead-looking areas on the town's grassy knoll.

While Truman slumbers, Christof treats his TV audience to a flashback of Truman's high-school years and his abbreviated assignation with Sylvia (Natascha McElhone), the girl of his dreams. Sylvia coaxes him to run off to the beach, where she tries to explain to him that his life is a television show. Her 'father' appears out of nowhere, whisking her out of the series and Truman's life. "They're seen in a wide shot," McAlister noted, "which tilts up to reveal the town in the distance. It was impractical to attempt an even level of moonlight illuminating an entire town, for even with the largest lamps we could only light the first row or two of houses. So to get a more hyperreal, even exposure on the rest of the town, I locked off the camera and filmed the shot again the following morning. As a post process, I darkened that first tier of houses shot at night, then brightened the rest using the dawn footage to create a too-extreme lighting depth. This type of night lighting was unrealistic, but I knew it was the right look for the film, stretching reality in a way that worked subconsciously. There are several barely altered images like this in the film–just enough to convey the feeling of this slightly different world."

Truman lives under constant surveillance from five thousand video cameras installed throughout Seahaven, units ranging from a buoy-cam capable of recording at water level in the ocean to a camera mounted in the ring he wears on his finger. To suggest spy camera technology, the outer edges of the film frame were usually masked by gobos–matte box elements shot in-camera. A number of other shots requiring similar masking effects were done in post by Cinesite Hollywood, while composites requiring Truman elements to be burned into TV monitors were largely the province of Computer Film Company. "Both Cinesite and CFC made a lot of terrific comps that didn't wind up in the film," McAlister acknowledged. "There wasn't anything wrong with the work; but it was all treated like straight production footage in editorial. Peter had to inform the audience that something was amiss, but without giving them too much information–he wanted them to

make their discoveries as Truman makes his. Peter utilized only what he needed to tell the story; so while we did multiple iterations for scads of Truman monitor burn-ins for him to experiment with editorially, only about ten percent of them appear in the final cut."

CFC also contributed heavily to a sunset scene featuring Truman and his friend Marlon (Noah Em merich). "They had tried to shoot the scene three times in Florida," McAlister explained, "but each time the fog rolled in, so it was decided to reshoot back in L.A. The very next evening, I was shooting second unit and saw a really spectacular sunset forming. Peter and Jim Carrey weren't around, so I got Noah Emmerich into his costume, then dressed a prop man as Truman and shot a master of them sitting on a rock, silhouetted against this gorgeous sky." An empty plate was also shot. Weir approved the impromptu shot, but when close ups were later filmed in L.A. during magic hour, the footage did not match. "The sky color was off. I took the shots to CFC, hoping they could put in a color gradient to tie them together. But they went one better, lifting Jim and Noah from this fairly neutral L.A. sky, then putting my empty sunset plate in behind them, making it appear they are conversing against that beautiful real sky."

Truman comes to find more and more of his environment suspect. After attempting, unsuccessfully, to book a flight to Fiji–where he is convinced Sylvia has been living–he notices the background 'extras' in his life are cycling, as if on a loop. His paranoia now at a crisis level, Truman makes a break for freedom, driving madly to the mainland with his panicked wife along for company. Forest fires and nuclear powerplant accidents are enacted to slow him down, leading to his eventual capture and return to Seahaven. Later, when confronted by Truman about her part in his so-called life, Meryl panics and breaks character, calling out to a hidden camera for help. After Meryl leaves Truman, Christof–seeking to salvage the situation with a plot twist worthy of any soap opera–reunites Truman with his TV father, now revealed as a victim of decades-long amnesia.

The nature and extent of Truman's world is revealed in a Cinesite shot of a vast computer generated studio dome tracked into a helicopter plate of Burbank and the Hollywood hills.

With this melodramatic turn heralded as a roaring success by the viewing audience, Christof sits for a "Tru-Talk" interview about his role in creating and producing the series. A shot revealing Christof in his control room above the studio begins with a wide view of the moon, then zooms into and through the moon, revealing it to be a translight construct behind which the minions of Omnicom toil. For the moon zoom, Cinesite digital visual effects supervisor Bradley Kuehn began with an MWD moon element. Texture-mapping it in Softimage allowed him to perform the extreme camera move without incurring the heavy image degradation traditionally associated with such moves. "We had to duplicate the camera's movement on the live-action Christof element as well," said Kuehn. "He's behind this big black-and-white image of the moon, which made it tricky to keep him visible while sliding him over to one side slightly as the shot progressed."

The interview commences with a behind-the-scenes look at the making of "*The Truman Show*" series. Designed by Imaginary Forces, the segment required Studio City video production facility

Electronic Data Systems to insert images of Jim Carrey into a series of huge outdoor TV monitors. In addition to these video-resolution composites, EDS also handled editorial for the shots, which lead into the big reveal showing that Seahaven–sky, sea and land–is entirely stagebound. “We pull back away from the town,” McAlister explained, “exiting out through a service door in this great structure containing Truman’s entire world, eventually revealing the huge dome in its entirety, nestled in the Burbank foothills. Creating the dome was truly the principal technical challenge on the show.” The dome was a CG building constructed at Cinesite, then motion-tracked and comped with a helicopter plate McAlister had shot of the Hollywood sign and the city of Burbank. The tiny figure of a workman in the dome’s doorway was McAlister himself, filmed against a full-size door segment built by Stirber Visual Network.

Once the design for the shot had been set, the details of the dome itself needed to be determined. “We went round and round about that,” recalled Kuehn. “The art department drawing indicated a ribbed, egg-shaped dome, but didn’t specify if the dome was supposed to look old or new. We wound up generating a lot of different looks in order to give Peter plenty of options.” After establishing the dome’s Hollywood location in the pullback, Cinesite created dissolves to two more distant matte paintings. The first used a still frame of the CG dome, while the final shot featured a much smaller element to represent the dome as seen from space.

Later that night, Truman eludes the cameras in his home and makes good on an escape. Christof rouses the entire town–from extras and bit players to series costars–to aid in the search for their unwitting star, and the looming moon suddenly transforms into an enormous searchlight–but Truman is not found. “The moon/searchlight element was unplanned,” McAlister recalled. “The idea came up during postproduction. Cinesite added a glow to our NASA moon element, then created a 3-D searchlight beam that plays over Areté water. The same kind of inspiration happened with the false sunrise that follows, which came to Peter as he watched a Cinesite demo tape of Areté water reflections. It was the kind of big spectacular shot Peter usually shies away from, but it was in service to the story.”

To help the searchers locate Truman, Christof orders a premature sunrise. The sun–constructed in Alias by Cinesite–hurtles skyward on Christof’s command, casting premature morning rays upon the already wakened town. To create a time-lapse-like shadow effect climbing across the people and structures of Seahaven, a real-time gag–achieved during a night shoot–was devised by Peter Biziou and key grip Chris Centrella. “They hung hundreds of PAR 36 bulbs,” explained McAlister, “then set up a hundred-foot black flag. At the appropriate time, they lowered the lights and raised the flag, creating a moving shadow across the foreground area of town.” Visual effects contributed to this ingenious solution by enhancing the lighting. “The sun had been simulated with keylight, but there was no ambient fill–without which it looked like it’d been shot on the moon. I waited until dawn and reshot the lock-off camera angle as an empty plate. The real pre-morning light from that gave us all the fill necessary to make the sunrise work.”

Truman is at last found, bravely confronting his water phobia while escaping on the sailboat *Santa Maria*. Christof orders up lightning and increasingly dangerous storm conditions in an attempt to force Truman to turn back. Peter Chesney's Image Engineering crew built hydraulic rigs to flip the boat in a controlled and repeatable manner, then devised a variety of special water dumps and wave makers to depict the storm. After discounting the use of Paramount's tank–due to its limited size–Chesney settled on Universal Studios' backlot tank, called Falls Lake, then executed a drawing to outline his plan for the storm setup.

Effects designer Peter Chesney and his Image Engineering team used wave machines and dump tanks to simulate a huge storm staged to prevent Truman from fleeing Seahaven in a sailboat.

Chesney next focused on specific engineering requirements for the storm. "There are five kinds of waveform patterns," Chesney commented, "and we custom designed our wave machines to produce one called a deep-water wave–even though Falls Lake was only six feet deep. This particular wave model worked best to create the look needed. We used two ten-foot paddle-type wave makers weighing five thousand pounds each. Set up out of phase, these units created a really good chop." Chesney wanted to use jet engines to break up the waves, but with Falls Lake located near a residential district, noise from the powerful units could prove unneighborly. "I managed to talk Steve Boyland's jet engine group into adding silencers to the engines. These cut most of the high-pitched scream generated at the muzzle."

Chesney sketched plans for twin fifty-foot-tall dump-tank towers–each with a twelve-hundred-gallon capacity. The designs went to CAD fabricator Digital Factory, which used a computer-controlled plasma cutter to produce the needed components, then shipped them to Image Engineering for final assembly. While the towers, jet engines and wave makers created an effective foreground storm, it remained for Chesney to create credible, yet dramatic storm backgrounds as well. "Our goal was to obscure the background without resorting to fog," Chesney said, "as we wanted to see as much rain as possible. Heavy-duty agricultural pumps drove four thousand gallons per minute of rain, with six fire hoses feeding a rain bar overhead and another dozen surrounding the action. Custom scaffolding towers each held three-hundred-horsepower wind machines. Set up in opposition to one another, they created a wall of blowing water."

Details of the setup behind the camera were of at least as much concern to Chesney as the on-camera conditions. "They only had two weeks to shoot the sequence," Chesney noted, "so to speed production along, I decided to keep the crew out of the water. We prepped camera setups on movable scaffolding pieces, then put in small floating docks to create access to the boat. After a

setup was finished, we'd move the scaffolding while craning the boat to a new position, at the same time flipping the dump towers around to the other side to get reverses–this was necessary since we always shot in the same direction, toward the big backdrop behind the tank."

When lightning–created through animation effects, courtesy of Available Light–strikes the mast, Truman is swept overboard, and the people of the outside world witness "*The Truman Show*" reach its dramatic pinnacle. "For Truman's fall," Chesney explained, "a motorboat was anchored in position to generate the water current that sweeps him away from his stationary sailboat. We did not want to pull him, because that never looks right. The motorboat engine was so powerful, the water current it generated just swept Jim Carrey away." Truman struggles back aboard and ties himself to the craft, which then pitches over in the turbulent waters. "We needed to take the boat through one hundred degrees of motion. This precluded the use of an internal gimbal, since it would need to go out through the hull–and, of course, show on camera. Instead, we went with an external gimbal, adding a boxed-truss steel frame inside the hull to reinforce it against breakage when the boat pitched over and slammed into the water." Hydraulic torque motors powered a dual-frame underwater rig, rocking the boat across three planes of motion. One frame moved the boat ahead and back, while the second provided the vertical motion needed to pull the boat down into the water and lift it back out.

Under pressure from both co-workers and network bosses, Christof switches off the storm, allowing Truman to resume his flight to the horizon– a destination he arrives at rather abruptly, as the prow of his boat punches a hole in the painted sky backing that marks the edge of his world. This surrealistic image, and Truman's emotional response to it, proved so powerful a moment that a series of incidents preceding it were eliminated. "There had been plans to show Truman passing huge wave makers and wind machines before he reached the sky wall," McAlister recollected. "This would have explained the level of technology used by Christof. But Peter decided audiences wouldn't give a hoot about machinery at this point in the story. And he was right. He was wise to eliminate the shots while they were still on the drawing board."

The cloud-and-sky cyclorama was a painted backing, suitable for close shots of Truman but lacking the degree of curvature and size necessary to suggest the sloping dome wall for wider views. "The cyc did not extend far enough up or to one side on the wide shots," Craig Barron commented. "As a result, there was an incomplete reflection of the sky in the water tank. We needed to extend the clouds on the sky backing to obtain a fuller sky reflection across the whole of the foreground water. But since we were going to repaint and extend the curved wall of the dome behind the boat, we really needed to replace all of the water as well, using Areté to get a proper reflection."

The approach, while bold, provided a kind of freedom in recreating the scene. "The boat and Truman were all we kept," remarked Barron. "Brett Northcutt created a traditional matte painting of the sky on the inside of the dome, making sure it resembled what they had done on their backing for the closeups of Jim Carrey. Composited by Todd R. Smith, it created an image somewhere between reality and perfection, which matched the rest of the sequence. It also maintained the idea of clouds that had been fabricated by a scenic painter or an artist–real clouds alone would have been too natural-looking." McAlister and Weir requested that the boat be repositioned, which allowed Jim Carrey to make a longer trek after climbing from the boat to a maintenance pathway at the base of the backing. Live-action of actor and boat was precomped with the Northcutt matte

painting, then lined up behind wholly synthetic Areté water in order to render each element's reflection.

Truman climbs a staircase set against the cloud backing, eventually reaching a maintenance door that will lead him out into the real world. Rejecting Christof's booming, God-voiced entreaties urging him to remain in his cradle, Truman elects to face the potential fears and dangers of life outside and steps through, triggering an early wrap for "*The Truman Show*" television series and concluding the film.

Truman reaches the end of his world. Painted backings representing the inner surface of the studio dome were later extended by Matte World Digital, which also replaced the tank water with CG water so that matte-painted clouds and sky would be visible as reflections.

Mike McAlister found the effort that went into sustaining the illusion surrounding Truman invigorating and worthwhile. "The most interesting aspect to it was the degree of subtlety involved. While there are some obvious visual effects shots, it was the subtle ones, working in harmony with production design and cinematography, that established our slightly skewed, hyperreal look. In terms of how it supported the story, I consider the work to be among the most profound I've ever done."

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JOURNEY TO ARMAGEDDON

image

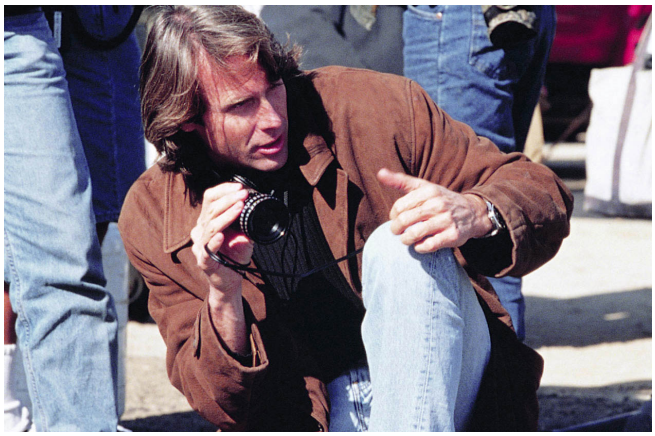
ARTICLE BY
MARK COTTA VAZ

Director Michael Bay, like many of his filmmaker colleagues, grew up fascinated with movie magic. As a boy, Bay staged a *Super 8* space fantasy in his bedroom, using model spaceships flying on strings, a bucolic train-set town and illegal fireworks. Though the final three-minute extravaganza pleased the budding filmmaker, he was already suffering for his art–his parents grounded him after his pyrotechnics started a fire and the local fire department had to be called.

Twenty years later Bay would be at the helm of *Armageddon*, the ultimate space movie and Disney's latest bid for summer blockbuster status. The Touchstone release would conjure up humankind's worst nightmare–a 'global killer' asteroid on a collision course with earth. The planet's only hope is a team of roughneck oil drillers who must reach the asteroid, drill eight hundred feet into its surface and insert a nuclear device that will blow the rock apart. The production was produced by Jerry Bruckheimer who, with his late partner Don Simpson, had fashioned signature action films of the eighties–films such as *Top Gun* and *Beverly Hills Cop*. Later, Bruckheimer had been mentor to Bay, a young filmmaker who had spent his early career directing commercials and rock videos, before moving on to the big screen with *Bad Boys* and *The Rock*.

The roster of production talent on *Armageddon* was heavy with Bruckheimer/Bay veterans, including production designer Michael White and director of photography John Schwartzman. Construction coordinator Greg Callas, another returnee, and his Set Right Construction company created an enormous on-stage asteroid environment. That set–enhanced by steam clouds and debris storms

In Armageddon, a high-octane space adventure, mankind grapples with the ultimate disaster scenario when a gigantic asteroid is discovered on a collision course with planet earth. Deliverance from global annihilation rests in the hands of a motley crew of expert oil drillers, drafted by NASA for a rescue mission that entails drilling deep into the onrushing asteroid to plant a nuclear bomb that will shatter it.



Embarking on his third collaboration with producer Jerry Bruckheimer, director Michael Bay enlisted some fourteen vendors–many of them veterans of previous Bruckheimer/Bay productions–to tackle the elaborate effects demands of the film's cataclysmic premise. Sharing visual effects supervisory duties were Pat McClung, who headed Vfx–an in-house unit formed specifically for the production–and Richard Hoover of Dream Quest Images.

whipped up by special effects veteran John Frazier–was so rugged that crew members pegged it the '*Hell Hole*' and the '*Pit of Despair*.' Frazier also took charge of building the Armadillo, an all-terrain vehicle and drilling unit that would figure prominently in the story.

The movie's off-world premise necessitated plenty of visual effects magic, as well. Approximately 240 shots–plus sixty wire removals–made *Armageddon* Bruckheimer's biggest effects show ever. While some fourteen vendors were assembled–including *Blue Sky* | VIFX, Computer Film Company, Pacific Ocean Post, Cinesite and Digital Domain–the leadership and lion's share of the work was divided between an in-house unit dubbed 'Vfx' and Disney's own Dream Quest Images, which had created effects for three previous Bruckheimer productions.

The core of Vfx was comprised of *Dante's Peak* veterans. Pat McClung shared visual effects supervisory duties with Richard Hoover of Dream Quest; Alan Faucher oversaw the model shop; and Richard Stutsman served as special effects supervisor. Operating out of a warehouse in *Culver City*, Vfx supplied most of the film's models–from a radio-controlled Armadillo to a Mir-like space station–and did much high-speed and pyrotechnic work, notably for a sequence of the doomsday mission's two shuttles making a perilous asteroid landing approach.

A majority of Dream Quest's eighty shots were complex composites requiring extensive CG production and stage elements, executed at the company's Simi Valley facility. In addition to simulating an asteroid the size of Texas, the Dream Quest team would produce a sequence that followed the shuttles from a space station refueling stop to a flight over the moon, into the debris trail of the asteroid and through its interior.

Besides such imagined space-age hardware as the Armadillo and an advanced class of space shuttles, the film incorporated the bigger-than-life reality of the U.S. space program, with the National Aeronautics and Space Administration providing un precedented access to its astronaut training and launch facilities for filming. Bay would marvel at the ultimate boy toys at his disposal, everything from a two-billion-dollar *Air Force* B-2 stealth bomber to a NASA space shuttle primed for blastoff from the Kennedy Space Center launch pad in Florida.

The journey to *Armageddon* originated in the offices of Gale Anne Hurd, who produced the movie in association with Bruckheimer. In October 1996, screenwriter Jonathan Hensleigh, who had worked on *The Rock*, approached Bay with his concept of a doomsday asteroid intercepted by a team of deep-core oil drillers. He named the leader of these two-fisted roughnecks Harry Stamper. For years, Hensleigh's notebook, full of nascent film ideas, had carried the equation: "Oil driller = Red Adair = Harry Stamper." The real-life Adair, a legendary oil capper, had capped his own career when his company joined the crews that successfully battled the inferno of the Kuwaiti oil fields, set ablaze during the *Gulf War*. Hensleigh had been struggling with a story that matched the mythic stature of such a character when his self-described 'Eureka' moment came with the idea of an asteroid approaching earth. "Although NASA can get to the asteroid's surface," said Hensleigh, "they need someone to dig a hole. So they bring in the world's foremost oil driller. It would be 'ultra-high-tech NASA meets the ultra-low-tech oil drilling world.' I told Michael that basic idea, and he loved it."

Considering the vagaries of Hollywood's development process, the gestating idea was born practically overnight. After some three weeks of hammering out a story, Bay and Hensleigh pitched it to Walt Disney Studios chairman Joe Roth, who not only greenlighted the film but supplied the

title *Armageddon*, the Hebrew name for the site of a final battle between good and evil, described in the New Testament Book of Revelations.

From the start, the production adhered to a sense of verisimilitude, going so far as to calculate impact projections with the help of Ivan Bekey, an eighteen-year-old NASA think tank wizard skilled in pondering futuristic 'what if' scenarios. According to Bekey, the impact of a space rock a mere half mile to six miles in diameter was enough to produce devastating effects on earth. In fact, such are the dimensions of the asteroid believed to have wiped out dinosaurs 65 million years ago.

Armageddon opens with a vision of that hypothesized prehistoric asteroid hit. *The God*'s-eye view from space follows a six-mile-long asteroid traveling forty thousand miles per hour as it tumbles past the moon to an ocean impact on earth, generating dust clouds and waves of fire which, for several eons, bring the curtain down on life. While Dream Quest originally was slated to create the nearly two-minute sequence, the company's already busy *Armageddon* schedule made it necessary to hand the work off to another company–*Blue Sky* | VIFX.

Michael Bay exhorted the effects company to not only create the ultimate asteroid impact but to make it look utterly 'cool.' The wholly computer generated sequence reminded digital effects supervisor Max Ivins of the 'Genesis Effect' from *Star Trek* II–even though that scene had illustrated the flip side to extinction, with the transformation of a dead planet into a garden paradise. Realized by the nascent Lucasfilm computer division, the Genesis Effect had been the first all-CG sequence in a feature film. "'Genesis Effect Revisited' is how I referred to it at the time," recalled Ivins. "The Genesis sequence was groundbreaking; but the difference between then and now is that there is a level of sophistication today's audiences expect. And because of the speed of computers, we can deliver that."

For the end-of-the-world opening, which would set the tone for the adventure, *Blue Sky* | VIFX flew the camera through a primordial field of nebular star patterns, following an asteroid created with Houdini modeling software. "Instead of digitizing a model asteroid and physically dragging points around," observed Ivins, "a big math equation in Houdini provided a physical object, with random functions able to generate a hundred different asteroids." RenderMan and a NASA lunar footage data base were used to create high-resolution texture maps for the moon, with separate displacement maps employed to paint in the highest resolution shadows and highlights for areas closest to the virtual camera.

The impact on the painted earth was augmented with 2-D effects, from flashing 'God-ray' Inferno effects to high-rez maps that layered in clouds and land mass. The asteroid's explosive eruption was created using a Houdini particle system to drive a Dynamation effect that burst with 800,000 particles. A wave of fire created by artist Tomás Rosenfeldt rolled over the planet as a prelude to nuclear winter. "Using Houdini, animators could read in the shader values for RenderMan," stated Ivins. "We also used in-house shader references to produce fiery edges for the charred earth."

Flashing forward to present day, *Armageddon* postulates an asteroid a hundred times the size of the dinosaur extinction rock. Ivan Bekey's rough calculations of the consequences of a Texas-sized wallop from space had shockwaves instantly flattening an area at least the size of the United States, worldwide earthquakes a hundred times more powerful than the one that leveled *San Francisco* in 1906, half-mile-tall tsunamis washing hundreds of miles inland, and total darkness descending

from the dirt and debris thrown up into the atmosphere. “When it hit, all the momentum would transform into energy in a fraction of a second,” declared Bekey. “That’s like a trillion ten-megaton atomic bombs exploding all at once. Even if some life survived–such as a few primitive forms deep in the oceans–it would take millions of years to evolve again.”

The film’s heralds of disaster are an advance stream of automobile-sized asteroid fragments showering down on several ill-fated spots on the planet. Early in the film, fragments strike the orbiting space shuttle *Atlantis* and the skyscrapers and streets of Manhattan. For the shuttle, Alan Faucher’s Vfx model crew fashioned a four-foot replica based on the actual *Atlantis*. The destruction sequence begins with a closeup of meteors ripping through a wing section, an effect realized with a quarter-scale miniature, its aluminum skin rigged with three hundred bullet hits. Dream Quest, which assembled the sequence, took a mid-layer of its own 3-D meteor field and executed articulate rotos to simulate fragments shooting through the shuttle moments before the final explosion. The hero shuttle, a brittle urethane model, was hung by wire thirty feet off the ground in the Vfx parking lot and detonated in a series of carefully synchronized pyrotechnic events filmed against the night sky.

A two-minute opening sequence by Blue Sky | VIFX reaches back into earth’s primordial past to re-enact the smaller, but still catastrophic asteroid impact postulated as a likely cause for the sudden extinction of dinosaurs some sixty million years ago. From a vantage point in space, the camera follows the computer generated asteroid, tracking it through a virtual starfield as it tumbles toward earth, blasting into the ocean and triggering destruction on an epic scale. Featured in the shot is a digitally matte-painted earth, enhanced with 2-D cloud and land mass layers. The explosive impact and rolling firestorm that follows were achieved with particle system software and other digital means.

The *Atlantis* explosion, as well as other pyro events orchestrated for the film, was made possible by a breakthrough timing box designed by *Robert* Hutchens while working on *Dante’s Peak*. With the mechanism completed for *Armageddon*, special effects supervisor Richard Stutsman had four boxes available, each equipped with ten timers that triggered forty electronic circuits and multiple hits. “We developed these extremely accurate millisecond timing boxes that were tied into and triggered by the motion control computer,” Stutsman commented. “Pat McClung could tell us at what frame he wanted to see the primacord go, what frame for a fireball–and we’d dial that into the timer. Once we were all hooked up and hot, we could just press a button and watch the show.”

A two-minute opening sequence by Blue Sky | VIFX reaches back into earth’s primordial past to re-enact the smaller, but still catastrophic asteroid impact postulated as a likely cause for the sudden extinction of dinosaurs some sixty million years ago. From a vantage point in space, the camera follows the computer generated asteroid, tracking it through a virtual starfield as it tumbles toward earth, blasting into the ocean and triggering destruction on an epic scale. Featured in the shot is a digitally matte-painted earth, enhanced with 2-D cloud and land mass layers. The explosive impact and

For the *Atlantis* blast, the complex, frame-specific sequencing progressed from rear to front, triggering

holes blown in the skin, flashbulb blasts and a blue flame mix. “Doing the math to figure the exact millisecond we wanted an event to happen got very involved,” Stutsman stated. “If they were shooting, say, at 120 frames per second, we’d have to figure how many milliseconds would elapse in one frame. David Greene was a master at planning out all the timings, making sure one explosion didn’t go too early and melt wires that triggered the next event.”

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The six New York City shots depicted CG meteors streaking out of the sky, with impact effects provided by John Frazier’s wrecking crew. Digital meteors throughout the show were supplied by a variety of companies, including Dream Quest, Pacific Title/Mirage Studio, Digital Domain, *Blue Sky | VIFX* and Cinesite. For the Manhattan hits, Pacific Title/Mirage took the lead in producing meteors with red hot cores and dark, smoky tails. Cinesite worked on sixty composites, some of which featured its own 3-D work, matching the look developed by PTM.

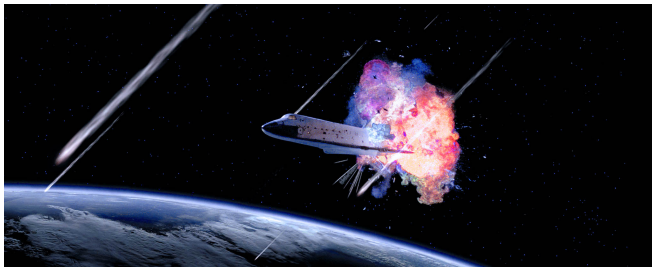
Among the meteor hits was a dramatic gag McClung dubbed the ‘three building hit,’ in which a meteorite slices off the distinctive spire dome of the Chrysler Building, blasts through the Grand Hyatt Building and explodes into Grand Central Station. The sequence culminated with the Chrysler spire plummeting upside-down into the street. Because of the vagaries of shooting in midtown Manhattan–particularly when scripted action required the closure of entire city blocks in order to catapult vehicles, blow up buses and drop flaming autos from cranes–a more manageable three-block area of downtown *Los Angeles* was cordoned off and made ready for the special effects crew. Later, New York skyline elements were digitally composited in to the live-action plates.

The L.A. mass destruction action took place during several weekend shoots, with stunt coordinator Kenny Bates directing stunt performers who, as pedestrians caught in the cross hairs of the cosmic event, would run pell-mell amidst chaos. Camera perspective tricks made it appear as if airborne cars, actually crashing at a safe distance of twenty-five feet from performers, were dropping in close proximity. Many of the gags engineered by Frazier’s team used ‘car flippers’–pneumatic rams which, positioned under the chassis of stationary autos, could launch vehicles ten feet into the air. Other cars were set aflame and dropped by cranes poised over the street. As a finale, Frazier simulated a meteor impact by wiring a bus to effect a series of explosions. The pyrotechnics were topped off with a car driven and launched from a pipe ramp smashing through a roof.

New York streets were not entirely simulated in *Los Angeles*, however. Manhattan location work was accomplished during separate visits by a small first-unit team and a Vfx Vistavision plate unit headed by McClung and effects director of photography Philipp Timme. McClung’s crew made an initial visit to New York in the summer of 1997, only to find they had to reschedule the shoot. “John Schwartzman had been in New York for months shooting *Conspiracy Theory*,” McClung recalled, “and he said summer light was terrible for getting deep, moody shadows. The haze acts like soft fill light, which lessens the shadows. So we had to come back at *Christmas*, when the sun was tracking low in the sky and there was less haze.”

The Vfx model shop created the architectural landmarks, including an ornate, twenty-foot-long plaster frieze replica of the Grand Central Station exterior, sculpted by Michelle Molee and Tulley Summer, then rigged with pyrotechnics and shot greenscreen. The Chrysler Building strike began with Vfx shooting a view up from the base of an eight-foot-tall, forced-perspective model, set against blue sky, the frame filled out with abutting model buildings obtained from L.A.-area rental houses. The initial blast was a greenscreen element created with an air mortar blowing out a mix of miniature girders, dirt and debris.

Shots of the inverted Chrysler spire dome and its top floor sections crashing to the street were designed by Pat McClung. Hunter/Gratzner Industries built two versions of the Chrysler model for the effect. Ironically, the company had already fashioned a Chrysler model that was trashed in another big summer release, *Godzilla*. Although HGI would use the same molds for *Armageddon*, the final model–sixteen feet tall and four feet wide–was built specifically to accommodate the unique skewering impact and collapsing effect that the filmmakers wanted. “Normally when we fabricate models,” said Matthew Gratzner, “we use steel armatures skinned with wood or plastic or fiberglass for structural integrity. For this model, we provided rigidity with cables crisscrossing from corner to corner. A flexible urethane was used for the spire dome so it would shatter on impact.” Packed into the hollow interior were tiny model chairs and desks, I-beams, plaster chunks loaded with lead to simulate concrete, and other identifiable debris supplied by Alan Faucher’s model unit.



Lethal fragments from the asteroid’s debris trail destroy the space shuttle Atlantis, a miniature built and exploded by Vfx, which handled the bulk of the show’s extensive model work. Compositing and digital sweetening for the scene were provided by Dream Quest.

A digitally rendered meteorite blazes toward a fiery impact with the Chrysler Building in New York.

Vfx crew members prepare to drop a model of the skyscraper's distinctive spire dome, fabricated by Hunter/ Gratzner Industries, for a shot of the upper part of the building plummeting to the street below.

Scaled greenscreen panels, standing in for real structures near the Chrysler Building, facilitated matting of shattered debris pieces bouncing off adjacent buildings.

While most of the background plates shot in New York utilized cameras without encoders, encoded *Los Angeles* location photography, by plate cinematographer Tim Angulo, was vital for the Chrysler crash. "Trying to track that plate would have been impossible without encoded data," noted Philipp Timme. The Chrysler plate had been a 24-frames-per-second tilt-down camera move shot from street level, complete with terrified extras running away from what would be the skyscraper dome's impact. "We didn't have a lot of leeway to make the data work because we were forced to work within the physics of dropping the Chrysler model. The model weighed a good 350 pounds and was dropped by a crane from a height of about forty-five feet, with a rate of speed that was not going to change."

A flaming automobile plummets into the street during scenes of meteor-induced mayhem provided by special effects supervisor John Frazier. Such scenes–actually filmed in downtown Los Angeles–were later enhanced with New York City skylines digitally composited into the live-action plates.

Prior to the actual shoot, Vfx fabricated two Chrysler mockups that duplicated the hero model's size and weight. After five test drops, it was determined that a camera speed of 72 frames per second would match the tilt-down's camera speed. Richard Stutsman's magic timing box was key in triggering a motion control pyrotechnic event that, at a specific frame, cut the wire supporting the model in front of an outdoor greenscreen at the *Culver City* effects facility. Although the first drop was technically flawless, a second was sweetened with further pyrotechnics. The final composite was layered with quarter-scale model cars flipping over and even falling people–business-suited per formers rigged with wires and filmed greenscreen.

Late in postproduction, Bruckheimer and Bay, having determined that the New York sequence needed additional impact, would approach Digital Domain to handle the work. "Since the Grand Central exterior hit was already accomplished," DD co-visual effects supervisor Erik Nash recalled, "their first thought was for us to work with that to make it look more impressive. But then visual effects supervisor *Robert* Legato pointed out that people are more familiar with the interior of the station. By cutting inside, we thought it would be possible to pull off something pretty impressive in the time available–which was only about six weeks." Legato and Nash proposed doing a series of five shots in which an asteroid fragment tears through the station's side wall and strikes the floor with explosive force. The resulting blast sprays debris throughout, engulfing the station and everything inside. For the asteroid itself, a lava rock weighing four hundred pounds was hollowed out and plumbed for propane, coated with rubber cement, lit on fire and filmed at a very low frame rate, creating a streaking fire element much like the one Digital Domain had done for its Apollo capsule reentry in *Apollo 13*.

With the Digital Domain model shop already ramping up for *Supernova*, miniature supervisor George Stevens and his crew of twenty were forced to work out of an ad hoc shop set up on one of the motion control stages. “They managed to build two *Grand Central* miniatures in just four weeks,” said Nash. “Since we only needed a particular section of the interior to be hit by the asteroid, each model consisted of just one side wall and the floor. That helped us out, because adding a ceiling would have left us with no way to light the set at the levels needed to shoot high-speed.” The model–measuring twenty-five by thirty feet–was duplicated to allow a second take.

Shafts of light brighten the cavernous interior of Grand Central Station just moments before a meteor plows through the wall. The explosive segment, conceived and realized by Digital Domain under visual effects supervisors Rob Legato and Erik Nash, required the construction of miniature sets replicating an interior wall and the concourse floor. The model work was subsequently extended with location footage of the real station.

Pyrotechnics specialist Joseph Viskocil orchestrated the asteroid strike, which was comprised of thirty events sequenced to take place in less than half a second. “Preceding the impact was a shockwave,” Nash explained, “that blew all the windows inward. Then Joe blew a hole in the wall with primacord, which we visually augmented with a large steel mortar up above. Firing that mortar toward the floor gave the wall hit a directional component primacord lacked. The floor impact was another primacord blast, with the resulting hole yanked downward via a cable pull.” A series of explosions beneath the floor followed, blowing debris upward and triggering rising fireballs.

Streaking fire in its wake, the meteor slams through the wall and into the floor of the station, an effect achieved on the miniature set by pyrotechnics specialist Joseph Viskocil. Panicked crowds fleeing from the destruction were filmed on a greenscreen stage and layered into the composite, along with a practical flaming asteroid element.

Remaining sections of the train station–the vaulted ceiling and a rear wall with large arching windows–were actual location elements, composited with footage of the wall and floor miniature. “Since the back wall and ceiling were unaffected by the initial hits and quickly covered by all the foreground destruction,” said Nash, “we used a still camera to take a number of pictures in rapid succession, then painted out people milling about on the floor. Next we applied a process developed by Mike Kanfer to average twelve of the pictures together, eliminating the painfully apparent grain that’s always visible on still frames. Later, in compositing, we added moving grain, scanned from unexposed, processed film stock.”

But before that could take place, it was necessary to repopulate the station. Between twenty and thirty extras were shot greenscreen in different groupings. “Every extra probably appears at least five times in the wide shot, which was done with Vistavision,” remarked Nash. “We covered the action with three additional anamorphic cameras to give them cutting choices, and two of these secondary angles were selected as cutaways–insert shots that also needed people added–so we used more greenscreen live-action elements there.” Numerous extras were positioned on patches of floor

that blew up during the shot, necessitating considerable roto work to make them disappear as the blast wave filled the frame. “Those shots had to come together quickly, and we turned them around in less than a week. People who saw the comps in progress thought the station was all background plate, which indicates what a phenomenal job the model shop did in terms of matching to it.”

The aftermath of the devastation is revealed in a sky view–a Cinesite composite depicting Manhattan after the meteor hits. Elements included a helicopter plate, the battered twin towers of the *World Trade Center*–done as a digital matte painting in Photoshop by Charles Darby–and fire elements photographed by Pat McClung and Cinesite compositing supervisor Kevin Lingenfelser, with several explosion elements borrowed from *The Rock*. “The most difficult part of the shot was tracking a major parallax,” said Lingenfelser, who had charge of the spectacular image. “I tracked points in sections of the background, mid- and foreground.” Matte-painted elements were tracked separately, while fire elements had to be frame-averaged to create the illusion of appropriate scale.

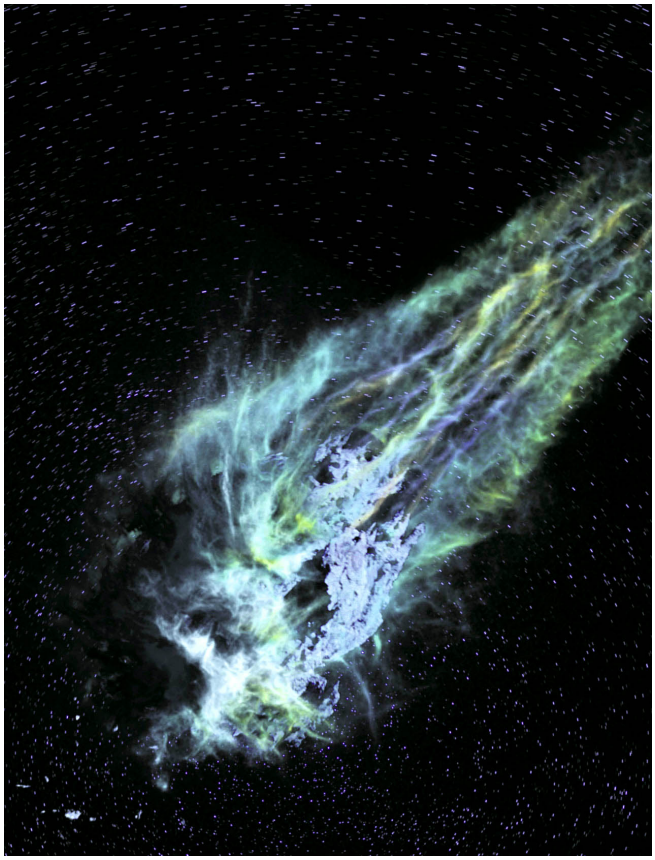
One of the riveting aspects of the aftermath was the image of the *World Trade Center*, its left tower with a gaping hole, its right with the rooftop missing. Darby painted the gaping hole twice–once with a flare effect to catch the sun’s rays shining through. “During the course of twenty-four to thirty frames,” Lingenfelser stated, “I dissolved between the normal painted hole and the one with the white painted flare effect. Another trick was the atmosphere–a smoggy look from all the fires–created by making the foreground explosion, fires and smoke opaque, and having the opacity levels drop off in the distance. Background fires were comped in at seventy-five percent value to allow the natural background colors to be seen.”

The devastation of the meteor shower serves as a wake-up call for NASA, and the agency conceives the idea of implanting a nuclear device deep within the mother asteroid to destroy it. Harry Stamper (Bruce Willis) and his ragtag band of roughnecks–among them ‘Chick’ Chapple (Will Patton), ‘Bear’ Kurleen (Michael Clarke Duncan) and Rock hound (Steve Buscemi)–accept the challenge of blasting the killer rock. Also signing on for the potentially suicidal mission is Harry’s cocky young protégé A.J. Frost (Ben Affleck), whose love for Harry’s daughter Grace (Liv Tyler) infuriates the senior Stamper.

The would-be heroes are first seen at work on a Stamper Oil semi-submersible rig in the middle of the ocean. The desire for authenticity led filmmakers to helicopter select cast and crew to an EEX Corporation oil rig in the Gulf of Mexico, a hundred miles off the coast of Texas. While the eight-story rig made for impressive establishing shots, hardcore action was filmed at an abandoned oil refinery in Carson, California. In a dramatic scene the roughnecks hit a gusher, an event simulated by John Frazier’s crew. “When you strike oil,” related Frazier, “and you have thousands of feet of pipe in the ground, a high pressure gusher will push all that pipe out. If you don’t get your pipe out in time it’ll shoot out, tearing up your oil derrick and killing or maiming people. The production wanted to see that.”

The oil strike was accomplished with a high-pressure pump that got the cast soggy with fake black dye oil. But it was serious business when Frazier’s crew began launching twenty-foot-long lightweight aluminum pipes. Positioned twenty feet below the base of the facility platform were air mortars, which shot as many as fifteen pipes at a time a hundred to two hundred feet into the air. “We aimed the pipes at a five-degree angle so they would blow over the heads of the actors–and

hoped the wind didn't shift," Frazier noted. "When you saw those things going up, it put the fear of God in you."



As meteor showers continue to pummel the planet, the mother rock speeds through space on its earthbound trajectory. Dream Quest designed the massive asteroid to project an aura of volatile, elemental evil, creating three practical versions that included a full motion control model. Digital effects enhanced the model photography, providing atmospheric haze around the meteor and a streaming tail of gaseous material.

Contrasting with the blue-collar feel of the deepcore drilling world, the story shifts to the pristine NASA training facilities at the Johnson Space Center in Houston, where the roughnecks under go an accelerated space flight training program, and then to the Kennedy Space Center launch site in Florida. While executive producer Jim Van Wyck represented the production on most of the meetings that paved the way for location filming at NASA sites, the Bruckheimer name carried a lot of weight. The glory of *Top Gun*, which had been used by the U.S. Navy as a recruitment vehicle, and an *Armageddon* script that embraced space travel as a heroic ideal, opened the normally restricted doors of the space agency.

Armageddon cast and crew alike spoke with awe of filming in the heart of an enterprise geared toward off-world adventures. "It's hard to explain," remarked Bay, "but when you see NASA, it's so patriotic! On the VIP tour, you walk the walk the astronauts take to the shuttle. You go through the white room that leads to the shuttle, and then you're on the gantry and the shuttle is just sitting there– this huge ship that's loaded with a four-million-gallon fuel tank and has 270,000 moving parts that all have to work together."

"Everything is '*Land of the Giants*' there," John Schwartzman commented. "One of the places we shot was the vehicle assembly building in Florida, where they put together the Saturn V rocket that went to the moon, and where they now stack the space shuttle. You could put Yankee Stadium on the roof!" To light the sixty-five-story structure, Schwartzman and his crew utilized one-ton transformers, lifting them up to five-hundred-foot levels with the aid of NASA construction cranes, capable of handling four-hundred-ton loads. It took a full week to pre-rig the massive set, all for a mere forty seconds of screen time. Other NASA film locales included the Johnson Space Center's anechoic chamber, which simulates space conditions, the hyperbaric chamber at Kennedy,

Grip Martin Hall examines stage rigging on the asteroid hero model. An interior mount on its off-camera side allowed for rotation of the model during shooting.

Software developer James Callahan created a proprietary renderer to produce the swirling, multicolored gaseous effect layered into the shots.

where astronauts back in the Apollo era were trained, and a Saturn V rocket thruster, within which sweethearts Grace and A.J. play a tender scene.

Particularly impressive was the neutral buoyancy lab, a 6.5-million-gallon, forty-foot-deep pool simulating the weightless conditions to be faced by shuttle crews who will eventually assemble in orbit the component parts of the world's first international space station. Not only was the high-security training pool made available for four hours of filming, Willis and Affleck were also allowed to suit up in real ten-million-dollar spacesuits. A bonus was a scene in which Affleck joined actual astronauts and their support teams training underwater–among them Shannon Lucid, who while aboard the Mir space station set the U.S. record of 188 days in space. "We have a wide shot of all these people underwater," Van Wyck commented, "and we move right into a priceless closeup on Ben."

While the NASA facilities proved an awesome backdrop, the utilitarian, workaday ambiance of Mission Control required a visual reinterpretation that could balance space agency reality with the visual verve of the production. "The old Mission Control, in use until just a few years ago, and even the new wing, look a bit pedestrian," noted Bay. "It doesn't fit into our minds of what NASA represents. We had to give it more gloss because I wanted the audience to believe this is NASA, that it's the highest tech." The film's Mission Control, built by Greg Callas' crew on stage at Culver Studios, was a two-story multi-level set that included an upstairs conference room with a view window looking down on a floor crammed with stations for a hundred technicians, the flight director's station–manned by fictional NASA executive director Dan Truman (Billy Bob Thornton)–and myriad video monitors and wall-sized view screens.

Just as Mission Control was enhanced with a high-tech ambiance, the film's interpretation of space exploration remained within the realm of reality but pushed the design envelope. The space station at which the shuttle teams refuel, for example, was patterned after Mir–but the scale of the Vfx model was double that of the real station. Likewise, the two mission shuttles, Freedom and Independence, were inspired by real space craft, but were transformed by Michael White's art department into a sleeker 'next generation' class thirty percent bigger than the actual shuttles.

Each of the shuttles would carry an Armadillo, the tanklike all-terrain drilling vehicle. Only two Armadillos would be constructed: one was a full-scale vehicle built by John Frazier, the other a Vfx radio-controlled miniature which could be adapted for the motion control stage. Frazier and his crew of fifty had only two months to complete their gas powered behemoth so it could be taken apart and trucked by tractor trailer to a scheduled location shoot in the barren badlands of *South Dakota*, which provided a natural backdrop for scenes of a shuttle team exploring the asteroid surface. The Vfx radio-controlled version would also be needed at the location, forcing the model shop to work concurrently with Frazier's team.

The full-scale Armadillo was a four-wheel-drive vehicle outfitted with an anti-rocket cannon, hydraulically operated prop drill bit rig and twelve tires weighing a thousand pounds each. The total weight was approximately thirty thousand pounds. Because of the Armadillo's technical complexities, Frazier took the lead in developing the mechanics, while the art department took responsibility for dressing the rig. "This was a case of form following function," said Frazier. "We picked a Humvee chassis for the Arma dillo because it's the only vehicle that offers all independent

suspension. We then modified the chassis, built the suspension and the tires." The mammoth tires featured a distinctive suction-cup tread design for traversing alien terrain. "You get tired of seeing these vehicles in the movies that go on the moon and have Goodyear radials on them! We made a special mold for the tires and had that pattern vulcanized onto a real tire. It was basically a retread. We started with a worn-out tire with no tread, which was sanded down smooth so that we could add back on an inch of rub ber. My shop made the design, and Goodyear vulcanized our tread onto the tire."

Constructed separately, by Greg Callas, was an interior buck, which had a front windshield, driver's wheel and seat, and a cab dressed out with switches, gauges and video screens. The cozy confines, some four feet across and eight feet deep, could be extended a full twelve feet with an added back section for over-the-driver's-shoulder shots. Although much of the buck shooting took place on stage, with a greenscreen positioned outside the windshield, in-camera work was accomplished during the Dakota badlands location shoot by bolting the buck to a moving camera car. The buck could also simulate the rock and roll motion of driving over the asteroid's undulating lava rock surface. "The buck's articulation was controlled with rams pushing air through air bags," Callas said. "There was also a shaker motor, like a flywheel designed to spin off-balance. By controlling the rpm's you could get the whole buck shaking."

The Vfx Armadillo was a quarter-scale model, six feet long by three feet wide. "It was constructed out of every material imaginable," Faucher elaborated. "The frame and all the suspension pieces were cut out of aluminum. We had pieces cast in urethane resins, others in fiberglass and some vacuformed styrene panels, as well." Crew members Cory Faucher and Doug Goddard were tasked with taking Armadillo production blueprints and figuring in the radio control equipment. "Fortunately, the model was quite large at quarter scale; so there was plenty of room inside the hollow mid-body to hide radio control stuff, the drive motors and everything else."

Each a fictional 'X-71' class spacecraft, the two super shuttles are presented in the film as top-secret *Air Force* ships unveiled in this, earth's darkest hour. The Freedom crew includes NASA astronauts and roughnecks Harry and Chick, while the Independence launches with A.J., Bear and others aboard. The space shuttles were created both in CG and in varying scales of practical models. Faucher was given shuttle concept drawings from Michael White's art department, then Vfx visual effects art director George Trimmer took those concepts and saw them through to the building of a twentieth-scale, seven-foot model for motion control work and a twelfth-scale, ten-foot model intended specifically for crash sequences. A quarter-scale, thirty-foot X-71 shuttle was also built by John Warren, Evan Jacobs and Doug Miller of Vision Crew Unlimited, then transported to the Kennedy Space Center for shots on the runway.

One of the Vfx practical shuttles was also used by Dream Quest to produce a CG model of the craft, with Mark Siegel taking the lead in creating the photoreal final. "We were very fortunate to have a beautifully painted and weathered shuttle on our stage," noted DQ digital effects supervisor Darin Hollings. "The physical models had to cut against our shuttles; so half our job was done since we knew exactly what ours had to look like. To gather surface details and textures, we mounted the model on a motion control rig and filmed it with a motion control camera. We shot from the front, the sides, rotating it forty-five degrees to get exact angles. We projected those textures onto our 3-D model using Alias/Wavefront Studio Paint. Then we added specular maps for the way light reacts to

surfaces, which is really important because with weathering some surface areas will be shiny, some dull."

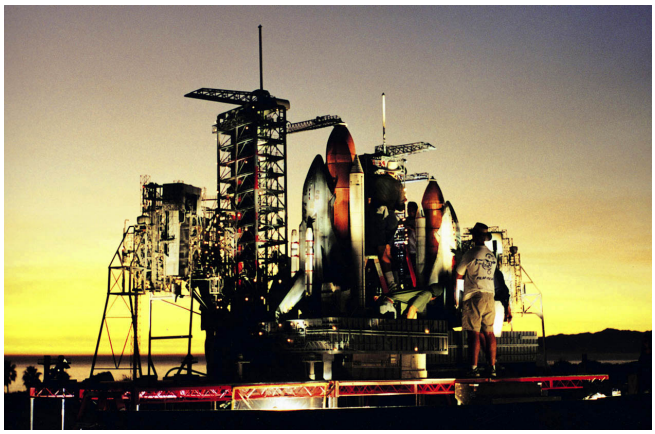
The dual blast-off of the Freedom and Independence utilized the twentieth-scale Vfx model which was digitally composited by Editel over an actual Kennedy Space Center shuttle launch. "I'd suggested to Michael Bay that for energy and visual impact nothing could be more spectacular than filming a NASA shuttle launch and replacing their shuttle with our shuttle," recalled Jim Van Wyck, "and he liked that idea." Although the production would be replacing the real orbiter–the technical name for the shuttle, which is attached at launch to an external tank and two solid rocket boosters–it would still benefit from spectacular footage of an actual shuttle launch at night. In June 1997, The *Armageddon* crew arrived to film a nocturnal liftoff of *Atlantis* knowing that, with a year and a half between night flights, they would have only one chance to get it right. As with the day launch filming, NASA cooperation was vital, especially in allowing Schwartzman to plug his Panavision movie cameras in to the space agency computer responsible for launching the orbiter. "NASA has about sixty still cameras and several video cameras for each launch, all of which are tapped into their computer system. That computer system literally starts and stops the cameras."

A separate camera countdown had the *Armageddon* camera shutters opening about forty-five seconds before ignition and closing approximately one minute after launch. Fifteen cameras were set up by Schwartzman's crew, with twelve inside the three-mile safety perimeter, including one looking down from atop the launch pad. All lenses were fitted with special filters to protect them from the rocket exhaust's wash of hydrochloric acid, and the cameras themselves were secured with some seventy sandbags to make sure that the concussive blastoff did not turn them into flying projectiles. Schwartzman also had to calculate film exposure for liftoff wattage levels that, in less than two seconds, would climb from two hundred to sixteen thousand foot-candles of illumination.

Additional shots in the blastoff sequence were assembled by 525 Post Production. For an aerial view looking down on the explosive event, Vfx model photography of the shuttles was combined with a digital matte painting of the launch site created by Computer Café, which also provided digital smoke and fire elements. Two subsequent shots–one of the shuttles rocketing past camera and another of the boosters staging and falling away–were likewise achieved by 525 Post using carefully finessed Vfx and Computer Café elements.

After a successful launch, the shuttles make a pit stop at a space station manned by lone cosmonaut Lev Andropov (Peter Stormare). The shuttles barely escape, however, before a refueling mishap causes the broken-down space station to explode. Vfx built two space stations, one a highly detailed twentieth-scale model made of plexiglass and styrene, the other a twelfth-scale pyrotechnic version made of cardboard and epoxy resins. Nicholas Seldon, a longtime friend of Pat McClung and a veteran model crew chief who had served with Faucher on *Dante's Peak*, oversaw the miniature space station build.

The miniatures were filmed with high-speed motion control cameras. Most of the miniature pyrotechnics–as well as model shuttle work on the Culver City stage–were shot anamorphic. “For the high-speed stuff, such as the exploding Mir station,” explained Philipp Timme, “we mostly used anamorphic 35mm, since Vistavision cameras have a maximum speed of only 200 frames per second.”



Mounting a last-ditch defense, NASA readies the Freedom and Independence, a pair of top-secret Air Force shuttles, for a simultaneous launch that will land two teams on the asteroid to plant a nuclear device in its core. Outside the Culver City warehouse serving as its studio, the Vfx team prepares to shoot a twentieth-scale replica of the launch pad in its state of readiness, complete with dual gantries and rockets.

Computer Film Company–whose slate of thirty-two shots included a number of long ones in the space station sequence–composited a greenscreen element of Peter Stormare into an entirely miniature environment. Employing a spiraling camera move, the shot began with a view of Andropov in a porthole window, then pulled back to reveal the orbiting space station. “The pullback combined six distinct motion control elements,” recalled CFC digital supervisor Rob Hodgson. “The interior of the station included a four-foot-high miniature wall, to which we added floating pens and books to indicate the zero-gravity nature, along with the greenscreen figure of Lev. The continuous pullback went out from a foot-across model of the porthole window to the twenty-foot-long hero shuttle model.”

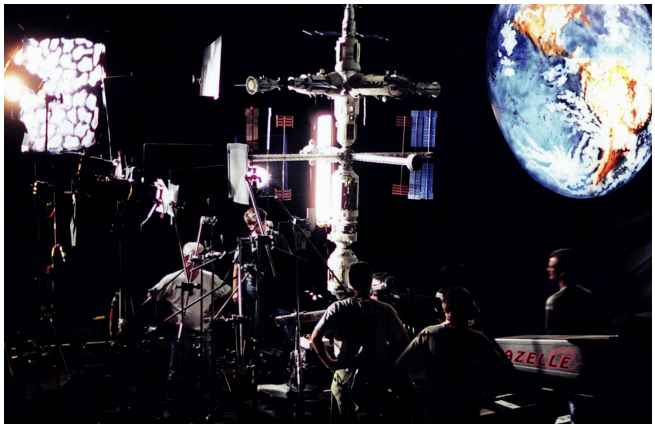
An aerial view of the blastoff, looking down as both shuttles climb toward camera, combined Vfx model photography of the ships with a digital matte painting of the launch site, created by Computer Café. 525 Post Production assembled and finessed the elements.

The Vfx motion control stage work, such as a greenscreen sequence of the shuttles docking at the space station, was complicated by the director’s affinity for ‘in-your-face’ shooting. “We found out quickly that Michael Bay liked to get real close to the models,” said Timme. “With a big motion control rig and a Vistavision camera on the end of it, our challenge was how to get literally inches away from the miniatures. We decided to use a snorkel lens and have the camera and motion control head off to the side a little bit, yet still close to the model. Chris Dawson, my motion control operator, managed to program everything from panning and rolling to tilting.”

The greenscreen stage elements were shot in layers, from beauty and matte passes to numerous lighting passes. “The advantage with shooting different passes,” Timme explained, “is that you can pull a key which allows you to get a better composite, as well as shoot different exposures for different passes. For example, there were tiny practical light bulbs in the wing tips of the shuttle models that required my shooting at two or even eight seconds per frame, while for the beauty pass I shot the same move, but with exposure times at a second per frame. If I were trying to shoot that

greenscreen element all at once I'd have to light the greenscreen for the lowest, darkest thing I'm trying to shoot–in this case, the tiny practicals at the wing tips. The motion control computer allows you to shoot the same move, but with different levels of exposure for each pass. It gives you more flexibility."

The space station pyro model was detonated in the Vfx lot in two separate sections, each hung from a cable thirty feet in the air. Cinesite and CFC shared compositing duties on the explosion. CFC's shots ranged from routine comps involving four or five elements to those with thirty to forty. "One of the tricky parts for us was understanding Michael Bay's vision," acknowledged Rob Hodgson. "The more he saw, the more he wanted in there. He has the best eye I've ever worked with. He doesn't want any area of the screen to be dormant; every frame has to be interesting. We put in twenty extra explosions, added interactive light on the shuttles, CG debris, a texture-mapped earth, glints, glows and highlights. We also did a complex reveal wipe from the fully detailed space station to the pyrotechnic model. The pyro model was a little bigger than the detailed model; so although they shot the same motion control move on both, the problem was lining it up. Also, where the pyro was smoking we couldn't have a defined wiping edge. We had to paint frame by frame to create those characteristics."



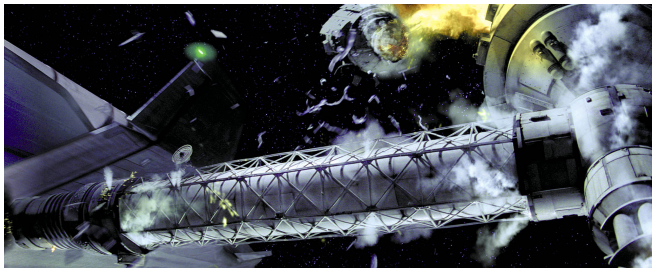
Following the successful launch, the shuttles dock at an orbiting Russian space station to refuel. A detailed model of the station, built by Vfx, is readied for filming on the motion control stage. Included in the stage setup was a large translight of earth, positioned behind the model out of shot range, to cast appropriate reflective fill light on the orbiting outpost.

Slingshot by the moon's gravity, the refueled shuttles gain sufficient g-force to overtake the asteroid, which is traveling at more than twenty thousand miles per hour. The thirty-one-shot sequence featured a Dream Quest starfield, a texture-mapped moon, a hero model of the asteroid embellished with DQ's own atmospheric gas elements, plus both CG and model shuttles–although the production would end up relying most heavily on the virtual shuttles, since the practical models would have to be digitally tracked.

Motion control miniatures were also used for a depiction of the twin shuttles docking at the station. Pat McClung and gaffer Dennis McHugh discuss stage lighting for one of the shots.

Because of the sequence's complexity, the action was plotted using previsualization tools. "We began with a digital animatic," noted DQ visual effects producer Rae Griffith-Gagnon. "We worked with Michael to determine the flight path, scale and speed of the shuttles as they flew through the asteroid. Michael is a visual director, and he responded well to the animatics. We were able to make any adjustments he wanted very quickly, which helped the production along."

"Because we spent less time figuring things out," remarked Richard Hoover, "we had more time to finesse shots and make them better. Our previsualization had everything: shot composition, shuttle speed and proximity to camera, lighting. The whole thing was cut, it had music, feeling and tempo. We also designed the story pacing through discussions Michael and I had about what was happening emotionally to the Independence and Freedom crews, who, having just escaped the space station explosion, then had to survive incredible g-forces."



A mishap during refueling causes the run-down Russian station to explode, very nearly destroying the shuttles in the process. Crews used high-speed photography to capture the explosion of a special pyro-laced space station model, divided into two sections detonated separately at the Vfx facility. Computer Film Company composited the elements, sweetening the shots with additional explosion effects, interactive lighting, computer generated debris and other digital enhancements.

The ultimate creative challenge was how to take audiences off-world. Dream Quest wanted to create a vision distinct from past science fiction movies, yet did not want the realistic interpretation of an *Apollo 13* or crystal clear NASA images of outer space. For starters, Dream Quest developed a starfield renderer that answered some of the traditional problems facing artists creating stars in the digital realm. "The classic problem is that when you motion-blur stars they streak and disappear," Hoover commented. "The traditional way of dealing with that is to put a dissolve in your 2-D comp to compensate, or to make the star brighter while it's being blurred and ramp down when a pan move is coming to a stop, and vice versa. Our software

did this automatically. Another problem is that when you make digital stars various sizes, the exposures differ. But our software balanced that out, so we could get a star field with different sized stars without also having varied exposure."

That ability to render stars of varying size and brightness was important. Dream Quest's star renderer used a special database to map existing constellations, novas and other heavenly bodies as they would be seen from earth in all their varied patterns and levels of brightness. If a particular angle held nothing but a dark void for background, artists could juggle the shot angle to catch a smoky piece of Milky Way or the view to a starry constellation. Another realistic touch was the use of space photos of the earth and moon supplied by Corbis, a private company based in Bellevue, Washington. Dream Quest technical director John Murrah texture-mapped the 2-D photographic images–which were also digitally enhanced with such 3-D details as bump maps for craters–to provide surface characteristics so that virtual lighting could produce dimensional shadows.

The flight above the mapped mountains and valleys of the moon was a thrill ride, with CG shuttle thruster fire adding to the illusion of g-force speed. "At first we were trying to be scientific about how many miles an hour the shuttles would go, how many minutes to get around the moon," recalled Hollings. "Then Michael Bay came in and said he didn't care about all that: 'It's just got to look cool!' That was our prime directive–not to throw reality out the window, but to let it slide."

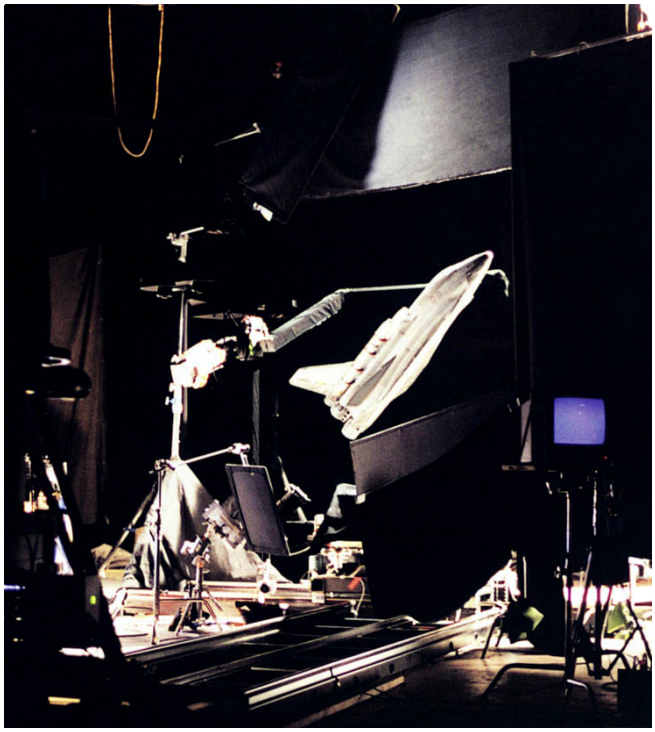
The vision of the asteroid itself had to convey an elemental force of pure evil. "The asteroid is the villain in the picture," Hoover noted. "It's the character Bruce Willis and his band have to confront and defeat. We provided a lot of attributes to underline that it's a volatile thing. It's erupting and rotating, there's turbulence and debris breaking off, which the shuttles have to maneuver through." While the asteroid's massive size would be apparent once the shuttles began their landing approach, the early question had been how to suggest perspective, scale and visual dynamism in the asteroid, as viewed from far out in space. During the design phase, while developing the gaseous tail Michael Bay wanted, Dream Quest found the solution–the asteroid's own gaseous cloud would provide an atmospheric haze. "We designed the gas to make the asteroid more evil and unpredictable looking; but its nature also gave us atmosphere and scale. The undulating gases allowed for turbulence and haze so the average eye could judge distance."

During the gas design phase, Bay specifically asked for a look that emulated the Hubble telescope image of the Eagle Nebula, a mass of distant stars and gases diffused with effervescent, multicolored clouds. "When I saw the conceptual art, I knew we needed something other than typical particle simulations," said Hollings. "I knew we'd have to write something ourselves." Dream Quest's proprietary gas software was jokingly christened '*Hookah*' in honor of the tobacco water pipe some software developers puffed on while playing chess and relaxing at lunchtime. "Our *Hookah* renderer was based on the idea that the best way to produce the asteroid gases was to generate large numbers of points in space and digitally push and sculpt them with different forces, such as radial forces spinning like a tornado and directional forces blowing in a single direction. *Hookah* differs from normal particle systems in the number of particles it can calculate and render. We could go from zero to the half- to three-quarters-of-a-billion particles we generated for *Armageddon*, as well as create fine, wispy details."

The gas clouds were built up in layers from front to back, as many as fifteen per shot. “Layering helped the compositing because you could get a faster render than if dealing with one big element,” Hollings remarked. “Rendering each layer separately also gave us freedom in compositing. We could put layers over or behind things, build up the gas clouds. We had control of colors and glows, transparency, how fast the gases moved, how they interacted with the shuttles or asteroid surface. To build the scenes we used *Alias*/Wavefront Power Animator. *Hookah* would interpret those scenes and then render out the gases.”

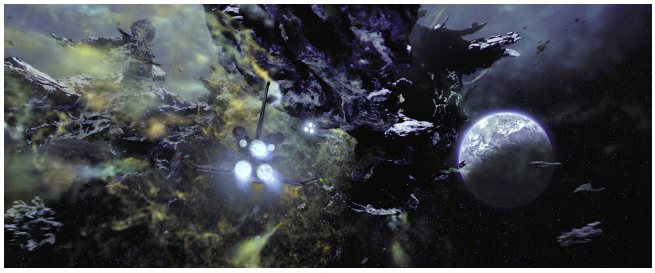
Ultimately Dream Quest created three practical versions of the asteroid, as well: the ‘tunnel,’ a set representing the fateful landing approach; the ‘spires,’ which were gigantic spiky rock formations at the tail; and a full hero model. The greenscreen hero model, from bulbous body to spiked tail, was twenty-five feet long and twelve to fifteen feet in diameter. A crew of thirty, led by miniatures art director Mike Stuart, crafted the asteroid with a steel armature covered by foam sculpted in bizarre contours to emphasize the alien terrain, then painted with green, red and blue aniline dyes, and metallic paints with patches of glitter to represent surface ice. Bay also requested a rotational effect, which Dream Quest produced using an interior rotator mount attached through the model’s off-camera side.

As with the other motion control work, the hero stage model was shot in multiple passes. “There was a production pass with the asteroid evenly illuminated,” DQ digital com positing supervisor Marlo Pabon elaborated, “a key light pass to accentuate highlight areas based on the sun’s direction, and interactive light passes.” *Alias*/Wavefront Composer served as the principal compositing platform. “Composer has some good keys for specific highlights, color value and matte pulls. Composer also has good tracking software for all elements, which was important because Michael



Multiple passes were required in photographing the shuttles on the motion control stage.

Modelmaker David Beasley adds finishing touches to a shuttle model, one of several versions built in varying scales.



Aided by a slingshot passage around the moon, the refueled ships overtake the asteroid, dodging rock debris as they close on it. The harrowing flight, created at Dream

Quest, featured numerous elements, including CG spacecraft, a practical asteroid model enhanced with digital atmospheric effects, a texture-mapped 2-D photographic image of earth and a virtual starfield. Detailed animatics were created to plot out the action and composition of the shots in advance.

Bay likes a moving camera at all times." A major compositing challenge was integrating multiple asteroid passes with undulating layers of *Hookah* gases, shuttle engine glows, vapors from damaged shuttle engines, and other transparent effects. "The shots turned out a lot more complex than expected because of the multiple layers of gases. It's very difficult to combine and layer a transparent element. The big challenge was how to stack as many as fifteen multiple layers of gases and make them look real. Each shot had a different background, so we had a different layering strategy from shot to shot. We also had to adjust the levels of the color spectrum for each layer, manipulating the color gamma, to make sure each CG element was being utilized to the maximum."

Compositing the *Hookah* gases was further complicated because the actual compositional integration of gases with asteroid stage photography was often undecided come compositing time. In some cases, Bay would ask for an unanticipated new twist on the look during postproduction. Once again the directive 'make it cool' carried the day. "On some shots," explained Pabon, "Richard Hoover had the stage crew shoot passes for different areas where he could previsualize that a matte might be needed. But putting together the shot, we realized we still had to add gases in areas where the stage photography hadn't done any matte passes. So we did a lot of hand roto to make the gases look like they were coming out of tunnels on the asteroid surface, wrapping around spires and so on."

The shuttles' harrowing flight path would overtake the asteroid from the rear, a hell zone featuring Dream Quest's swirling gases, rocky detritus–created from eight different rock fragment motion control elements that ranged in size from one to four feet in diameter–and miles-long spiked rock formations. Those greenscreen spire elements filled the facility's 135x75-foot stage. The motion control shoot utilized six different set pieces arranged in various combinations, including three giant spires that measured seventy feet long and four to eight feet in diameter. "We'd start wide, then get closer on the spires," said Hoover. "With a key source for the sun, we first shot clean, then in smoke to get shafts of light between the spires."

Deeper inside the asteroid was a tunnel, an eighty-foot landscape scaled out as a miles-long crevasse lined on each side by overhanging rock formations. To achieve the gritty, closeup look of alien rock, Dream Quest modelmakers glued together and carved blocks of rough-textured packing bead foam for the base pieces, with finer grades of foam used to sculpt spires and other landscape details.

With the shuttles' descent onto the asteroid surface, events take a shocking turn as the Independence crashes and most of its crew is killed. Only Harry Stamper's Freedom shuttle makes a successful, albeit bumpy landing. Both the crash of the Independence and the hard landing of the Freedom were realized with twelfth-scale, ten-foot-long X-71 models shot high-speed on the Vfx stage. Pat McClung oversaw the shuttle shoot, while Richard Stutsman took charge of rigging the complex overhead track and trolley, built by Mark Stanton and Steve Austin, that would be used to execute the violent landings. "The overhead rig was controlled by a computerized motor run off a laptop," said McClung, "which got the models going thirty to forty miles per hour–a velocity needed

because we were overcranking the camera. It's pretty frightening to have something as big as our shuttle models flying down a track at that speed."

The overhead rig was equipped with a computer controlled winch designed by *Bob Wilcox* of WKR Productions. "The high-speed cable winch was basically an electric motor with a gear box that spooled cable at varying speeds," observed Stutsman. "The winch itself was bolted into the ground with an endless cable system going through a pulley and up to the track where it hooked to the trolley. So if the winch went in one direction, the trolley followed; if it stopped, the trolley stopped. If you have to pull cable or rope at a high rate of speed, and be able to repeat it within inches, this winch is the hot ticket." The variance in cable spooling speed provided the effect of wobbling, wounded shuttles. The Freedom was rigged with two cables at the wing tips and one at the nose, while the crashing Independence was hung from the overhead rig by two cables, one each at nose and tail, so it could be made to spin crazily. "For the hard landing of the Freedom, Jeff Denes hooked our winch to what I call a 'shark-fin track' underneath the set and dragged the shuttle by the front landing gear through the set." Extensive set redressing was required after each take, as the model plowed through breakaway glass icicles and rock formations. The action was enhanced with air mortars blowing debris and pyrotechnics, set off with Stutsman's timing boxes.

For the Independence crash, the spinning model had to lose a wing after smacking into a vertical spire set piece. "Interior glass tubes held the wings on but were thin enough to break," Pat McClung noted. "There was a triggering mechanism on the surface of the wing itself; so the moment it hit anything, it set off a whole chain reaction of timed explosions."

Complicating the shuttle landing shoot were the structural limitations of Vfx's temporary facility in Culver City. Although the stage area was sufficiently wide to allow for an eighty-foot sweep, the low, twenty-five-foot ceiling created problems. "This was an industrial warehouse built to minimum code standards, so it wasn't particularly movie-friendly," Stutsman lamented. "The models and the weight of all the rains from El Niño pulled the roof down about three inches as we flew the shuttles."

A cutaway to earth reveals major population centers leveled by the continuing meteor showers. Slamming into the heart of Paris, one massive asteroid fragment sets off an atomic-like shockwave of fire and earth that decimates the city. To simulate the shockwave's expanding trajectory, Dream Quest visual effects supervisor Hoyt Yeatman staged a large-scale pyrotechnic blast at Hanson Dam in nearby Lake View Terrace. Concentric rings of primacord were laid down on a raised steel pad, covered with tons of loose dirt and sand and detonated in rapid-fire sequence, along with a cache of aluminum powder at the horizon line for the impact flash. High-speed cameras captured the event from the safety of a protective bunker.

"I didn't have enough room to get lights overhead," Philipp Timme added. "That was a problem because John Schwartzman had established, on the Disney stage, these fingers of light–what we used to call '*God Light*'–filtering through the weird asteroid rock formations. We had to cover a larger area, since our set was supposed to be twelfth scale, and make this variety of lights appear to be one big backlit source. We couldn't get far enough away for a single source,

so we had to fake it. If we'd had more room, I would probably have used four 18Ks, more concentrated sources of light. Instead we used a lot of single lights as high up in the roof as we could go, everything from a 6K down to a two-hundred-watt PAR, all set up to simulate this big, faraway light source."

The final composite, a view from atop the Notre Dame cathedral, incorporated foreground plates of the real Paris and miniature rooftop gargoyles.

To hide the ceiling lights, which were visible from certain camera angles, Timme's crew cheated the view with foreground rock set pieces. Some creative set dressing was also employed to conceal shortcomings of the facility itself. "There were supporting poles about every forty feet holding the building up," said McClung, "which our art director, George Trimmer, worked into our set, overlaying them with vertical, styrofoam rock formations. Everything was portable, so we had big, carved styrofoam rocks that three guys could pick up and move around to accommodate the particular angle of each shot."

One tricky effect in the landing aftermath was a locked-off shot looking up at the Freedom at rest, its ramp lowering down to reveal five of the crew poised to descend to the surface. The shot employed a shuttle model filmed at Vfx–originally with six-inch puppets literally glued onto the brink. "The puppets didn't work," remarked Cinesite compositing supervisor Kevin Lingenfelser, "so we filmed one space-suited actor greenscreen in three poses. In the final, there are two puppets in the background, a middle greenscreen guy turning his head, and two moving figures in front, with one guy taking a step."

Throughout the movie, the doomsday countdown is punctuated by more deadly meteor showers. One disastrous hit, which further awakens the world to the impending peril, wipes out an Asian harbor with the force of a nuclear shockwave. The so-called 'Shanghai sequence' had originally been storyboarded by Dream Quest; but with the facility's production plate full to overflowing, *Armageddon* again turned to Digital Domain and Rob Legato, fresh off an Oscar win for his work on *Titanic*.

The original storyboard had featured a wide shot of a meteor landing out to sea, ending with a shockwave effect. Legato felt that the inherent lack of contrast between blazing meteor and daylight sky, coupled with an absence of foreground objects, would result in a shot with minimal dramatic punch. He proposed a new composition based on a dramatic black-and-white photo of Hong Kong harbor taken in the late 1950s. "I believe if a shot is interesting prior to the effect, the effect itself is more compelling because you're already interested," stated Legato, who co-supervised the sequence with Erik Nash. "You'll be seeing something destroyed that you have an emotional connection with, as opposed to just cutting to a shot for the effect." The new composition had two foreground docks, boats in the harbor, a distant hillside across the marina and a surrounding cityscape. In the revised twilight tableau, lingering rays of sunshine silhouette the boats even as lights along the neighboring row houses begin to wink on. Then comes the meteor slashing through the sky from camera right, crashing into the middle of the bay and causing a shockwave that rips through the boats and docks.

Digital Domain's composite elements included twenty-foot-wide, quarter-scale dock miniatures and buildings built by its model shop–led by George Stevens and Gordon Forkert–and shot greenscreen. Other elements included CG water, a matte-painted sky, interactive lighting reflecting the passing meteor, and a meteor element composed of a porous rock loaded with propane and rubber cement

set aflame and shot against black, then topped off with a computer generated tail. “We shot the model buildings individually, and fairly large in frame, because we’d decided to use a long-lens technique on our shots,” noted Legato. “The traditional thing is to use wide-angle lenses; but a long lens compressed the shot. We then shot interactive light passes of the incoming meteor for each building. Once all the building elements were composited together by Mark Forker, it had the appearance of the back buildings first being lit up, then the next row of structures, producing a three-dimensional lighting move for the falling meteor.”

An aerial view of Paris reveals the meteor’s swathe of destruction. Matte World Digital created the image using as its foundation a scanned photograph of the city. Melded with a practical impact crater model, the digitally massaged shot included moving CG cars, destroyed buildings and layered atmospheric effects.

The shuttle teams–now on the asteroid surface–are taking a beating as well. Live-action shots of the off-world site were filmed on a giant asteroid set built on a soundstage at Walt Disney Studios in Burbank. Throughout the shoot, effects crews dropped jagged set pieces from the rafters to simulate the asteroid’s violently unstable condition.

The harbor meteor blast combined stage pyrotechnics with a computer generated shockwave. “Instead of just creating a physical explosion, we used a shotgun blast,” recalled Legato, “basically a big blast pipe packed full of tiny glass beads that we positioned off camera behind the dock set. The blast that pummels the docks, when mixed in with the CG element, looks like the shockwave itself is destroying the docks.”

Shanghai falls victim to another deadly meteor strike. Digital Domain concocted the sequence, a composite of numerous practical and digital elements, including greenscreen model photography of the dock, a practical exploding meteor, CG water and stage pyro for the harbor blast.

Later in the film, with Harry and his team already off-world, a massive asteroid fragment streaks across Europe and slams into Paris. Cinesite contributed a 3-D meteor for three separate shots of the space rock flying over Parisian rooftops. Unlike the one whose smoky tail they had to match in the earlier New York sequence, the later version featured a unique hot core, popping with red embers, and a reddish tail.

As with the Shanghai sequence, Paris was targeted for disaster to underscore the peril facing the planet. The sequence was assigned to Dream Quest, which had about one month to complete the work before the cutoff for the entire production. DQ art department head Allen Battino devised a composition placing the audience’s POV on a perch atop the famed Notre Dame cathedral, with a gargoyle statue sitting foreground right, chin in hands as if contemplating the horror.

Dream Quest senior visual effects supervisor Hoyt Yeatman, who was given the reins of the sequence, saw an opportunity to push the boundaries of high-speed photography and computer controlled pyrotechnics, a personal interest he had previously indulged in *Crimson Tide*. In that Bruckheimer thriller, a series of explosive and implosive blasts was fired by computer within a quarter of a second to destroy a twenty-foot submarine. “The idea in the Paris sequence was to use high-speed photography and computer controlled explosions, but ramp them up,” said Yeatman. “Explosive events done within a short time produce very unusual dynamics. I’d done some research and found that a relatively small asteroid, like the one thought to have killed off the dinosaurs, can travel as fast as 400,000 miles an hour. At those speeds the impact would cause a wave-like action. I wanted to create a veritable tsunami of earth rising a thousand feet in the air. The effect would begin in the distance and come forward at the speed of sound, creating the feeling of the camera and the audience being enveloped in the impact wave.”

While a Dream Quest plate crew flew to Paris to photograph the city from atop the Eiffel Tower, Yeatman and a team that included freelance pyro master Richard Helmer staged the explosive effect at a Southern California dam and rock quarry. Earth movers dug out a dirt pad one hundred feet across and ninety feet deep, tilted eight degrees to allow for an unobstructed sky view. Cranes then hoisted, onto the raised dirt, inch-thick steel plates that were welded into position. Atop the steel surface, six thousand feet of primacord–more than a mile’s worth, all of which would be detonated in four-tenths of a second–were laid out in eighty-four separate concentric rings and

covered with a calculated mixture of sand, mulch and fuller's earth. As a final touch, eight five-gallon cans of aluminum powder were placed at the horizon line to produce an impact flash.

The computer-triggered pyro was filmed using a Photosonics 4E camera set at 300 frames per second, with a pause between the powder blast and the primacord explosions. "The powder flashed ten times as bright as the sun," remarked Yeatman, "so we had to time a pause of ninety milliseconds after the flash to give it time to develop before the primacord detonated. We got the wave action we wanted on the first take."

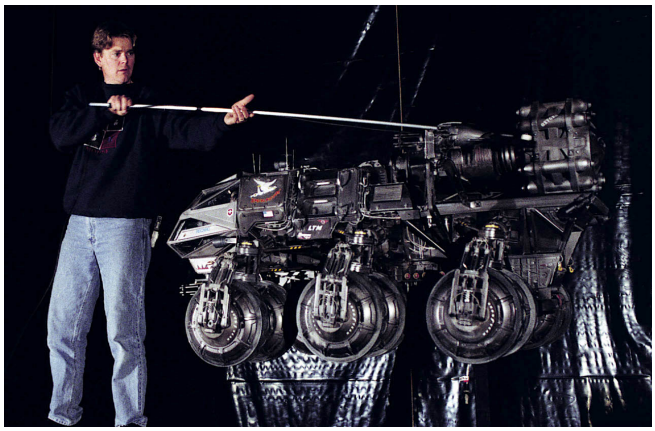
Swept away by the wave was a virtual Paris comprised of 3-D buildings texture-mapped with Landsat photographs and plate photography elements. "As the practical wave front came to camera, we had to digitally blast the 3-D buildings," explained Yeatman. "We created a virtual cylinder that traveled along the plane and intersected with the 3-D buildings, which we'd programmed with particle technology to break apart." The final composite included the digital asteroid, background sky from the pyrotechnics shoot, matte-painted touches of interactive light on the clouds, bluescreen elements of flying doves and carved-foam gargoyles blown up with air cannons. Some fifty elements were ultimately integrated into the shot.

Much like earlier scenes of New York in ruins, the full extent of the damage would be revealed in a helicopter establishing shot. The Paris aftermath would show the consequence of the rock's impact, with nearly the entire metropolis buried under tons of seared earth, boulevards pockmarked with craters and fires, and the Seine pushed off its banks by the mouth of the massive crater. In the center of it all, damaged but still standing, is the venerable Arc de Triomphe. The shot–the last one finaled for the film–was created by Matte World Digital under the gun of a two-week turnaround.

Matte World used as its template a high-quality, helicopter-view transparency lent by *Robert* Cameron, author and photographer of Above Paris, which was scanned into a 100-megabyte file. Also scanned for the visual foundation was an eight-foot-long crater model, fabricated by Sean Joyce and photographed in daylight. Artist Brett Northcutt then massaged and melded photo and model using Photoshop. "The first take was done three days before the negative was cut in," noted Matte World senior artist Chris Evans. "Two days before the drop-dead deadline, Michael Bay called and said he wanted destruction-to-the-max. At that point both Brett and I got on it."

The layering of elements included digital cars moving on the streets, CG fire and smoke, pocket craters detailed with shatter lines, added building faces, and more texturing for the mountainous, moonlike crater. Chief digital compositor Paul Rivera added a multiplane effect, dividing the shot from background to Arc de Triomphe foreground, which provided a subtle parallax. "This shot was our homage to Irwin Allen disaster movies," mused Matte World visual effects supervisor Craig Barron. "Our final shot was 4,600 pixels wide, double the normal resolution. There are a lot of details you won't see; but if they weren't there, the shot wouldn't look right. We kept the Arc de Triomphe fairly intact because it's an icon of Paris and the only thing that tells you where you are. Having some intact buildings also provided a scale reference to the destruction."

Having crashed on the asteroid, survivors of the Independence attempt to rendezvous with the Freedom by making a perilous low-gravity leap across a rocky chasm in their tanklike Armadillo drilling vehicle. Richard Hoover shot the jump on a greenscreen stage with a Vfx model of the all-terrain vehicle configured for motion control. The element was then composited with model photography of the asteroid surface and a digitally enhanced background view of earth, derived from NASA photographs.



Hoover maneuvers a lipstick camera on a pole to capture previsualization video for the Armadillo scenes.

Back on the asteroid, A.J., Bear and Lev survive the crash of the Independence and leave the site in their impregnable Armadillo, eventually finding themselves in an arid, mountainous area. Harry's Freedom team, meanwhile, has landed in a deadly area thick with spiked rock formations. While the Freedom base played out its live-action on the Stage 2 asteroid set, the Independence crash site utilized the desolate Dakota badlands for scenes featuring both the full-scale Armadillo and radio-controlled version driving off in search of Freedom.

Dream Quest crews built a miniature segment of the asteroid surface to correlate with the live-action photographed on the full-scale set.

During the badlands shoot, the Vfx Armadillo had a potentially devastating accident. As the remote-controlled vehicle was being driven along a rocky cliff ledge, the operator, steering from a quarter-mile away to be out of wide-angle camera range, made a wrong turn and the vehicle tumbled off the cliff. While not demolished, the model was broken, particularly the fiberglass front cab, which required the insertion of new plexiglass windows. Following a distress call to the Culver City shop, Alan Faucher, who had not gone to the location, assembled the rest of his model shop crew early the next morning. "We had multiple pieces at the shop that had been cast but not taken on location," Faucher recalled. "We had to put together the cockpit from scratch, painted and in a box, by three that afternoon so we could ship it out that night."

The vehicle was repaired and running with an estimated loss of only a quarter day of shooting time. Faucher hailed his Culver City crew for its quick response to the distress call, and had special praise for the on-site team of Cory Faucher, Eric Stohl and Greg Bryant. "Although they had taken a support box with them," said Faucher, "they didn't have a lot of tools and spare parts. When you're on site, a damaged model doesn't go back together nice and neat the way you built it on a tabletop in the shop. Suddenly you're relying on instinct and raw talent. That means using a hairpin instead of a cotter pin, or an old piece of metal you find on the ground. But with talented people you can literally get anything done–and those were the kinds of people we had there in the badlands."

Once the miniature Armadillo returned from the badlands it was featured in the 'Armadillo jump,' a sequence in which the Independence vehicle shoots over a chasm separating it from Freedom base. Richard Hoover supervised the sequence at the Vfx stage using the overhead rig that flew the shuttle models. But first the radio-controlled Armadillo had to be reconfigured for motion control. "It was quite a conversion," said Faucher. "Cory's team had to pull out the radio-control gear, lighten the vehicle by a third, replace the suspension with solid axles and install stepper motors for the flight scenes, which were shot at Dream Quest." The Armadillo's suspension was also modified to simulate an object floating through the gravity-weak space of the asteroid. "A hard axle was inserted through the twelve wheels," Hoover noted, "so there were three basic axles, each powered

by a different channel. That way, we could make the wheels turn at slightly different rates, as if they were floating through the air."

The Armadillo jump evolved from a straightforward, shoot-the-gap effect into a thrill ride featuring exploding surface geysers, ice and rock debris, deadly rock spires and the constant threat that if the Armadillo rose too high it would break the tenuous hold of gravity and float into space. Except for a couple of greenscreen shots, the scene was shot practically, with the miniatures crew blowing nitrogen and rock salt by the flying model to simulate the environmental effects.

At one point, the Independence Armadillo narrowly escapes drifting into space by banging into a rock outcropping, which knocks it safely back to the surface. Less fortunate, however, is Harry's Armadillo, blown into space after drilling into an erupting gas pocket, calling for a rescue by the Independence crew. "For the eruption, we filmed a pyrotechnic background plate on the Stage 2 set, with Michael doing a pan and tilt-up on it," related McClung. "Our quarter-scale Armadillo was hanging on a cable rig in front of a greenscreen; and on cue we just pulled it up really hard, to make it look like it was blasting off."

The Stage 2 asteroid set proved as formidable as any rugged location shoot. Rising up into the ceiling and filling the soundstage's four walls was a landscape of jagged spires, sculpted lava rock floors and an open pit drill site. The set was a dangerous place, with sheer drops onto spiky set pieces in some dark corners. Originally the production wanted to construct it in a gigantic blimp hangar in *Orange County*; however, Disney, intent on keeping a lid on the *Armageddon* budget, had balked at the expense, suggesting instead a serious look at Stage 2– the biggest soundstage on the Burbank lot, but still considerably smaller than the hangar. Greg Callas proposed a compromise– build on Stage 2, but approximate the desired scale by going underground. "It wasn't a totally radical notion," Callas reasoned, "since we often cut holes in a stage floor to create a pit or basement. I've just never had anything that big taken out before." Structural engineers were soon drilling into the four corners beneath the raised foundation to determine if the soil could be adequately compacted. Once the approach was green lit, a construction company began excavating a dig area ninety by seventy feet, descending some twenty feet.

Set construction commenced with the building of steel scaffolding to rough out the main contours of the asteroid environment. Meanwhile, Callas' crew, working out of Stages 1 and 3, built the alien spires and various rock formations in sections for assembly on Stage 2. Each major piece consisted of a steel skeletal structure covered with an aluminum screen welded together. Some pieces were spray-foamed at thicknesses ranging from three to eight inches, sculpted, then finished off with a protective hard coat and a final paint job. Other pieces were rendered as heavy plaster props.

The solid lava flow surface had to support twenty-ton boom lifts from which the set would be painted, as well as the fifteen-ton Armadillo that would eventually be driven into the pit area for filming. To handle the weight, the lava flow was fashioned from eight inches of poured concrete. "We had sixteen concrete trucks lined up outside the stage and they all dumped concrete into a pumper, which we used to fill up the whole area," Callas recalled. "Once it was poured the guys hand-worked it, giving it a definite asteroid look."

Throughout the asteroid set shoot, John Frazier and his crew were dropping gigantic set pieces from the ceiling, setting off pyrotechnics, and stirring up an elemental fury easily worthy of a global

killer. “You had to be careful on that set,” recalled Frazier. “It was slippery and wet, hot and humid from all the steam used to create atmospheric smoke. The steam provided a great look–an eerie feeling–but it made the set miserable. This was a place you didn’t want to be.” The performers suffered as well in their bulky, hot, seventy-pound spacesuits equipped with heavy air packs and radio hookups for communicating with the director when their helmets were snapped on.

For drill-site debris storms, Frazier and his crew showered the actors with material blown through the sculpted canyons at speeds of one hundred miles per hour. Frazier based his debris recipe–which included cornflakes–on what would best reflect light. “You have to use light material that will travel a long way and won’t hurt the performers,” Frazier elaborated. “We’re finding out that some of the substances used in the past, like vermiculite, are carcinogenic. Nowadays, we try to be environmentally correct and look out for the health of cast and crew, so we look toward organic materials.”

The asteroid, as if sensing that the space-suited interlopers are attempting to destroy it, increases the force of its surface storms to ground-shaking intensity. Special effects included a mechanical fissure section that could open and close on cue, the excavation having been dug an extra ten feet to accommodate the hydraulics system that Frazier’s crew operated from below. “Rather than do a traditional movie earthquake effect, where you see the ground collapse, we had the idea of pulling the surface apart,” remarked Frazier. “We built it as if it were a theme park ride.”

As Harry and his crew fight debris storms, the seemingly impregnable drill surface and dwindling doomsday clock, tension is heightened by three Cinesite composite shots showing the fragile blue earth just beyond an outcropping of spiky rocks. The elements provided Cinesite included a Corbis earth photo for texture mapping, Dream Quest files for gas and starfields, and views of the massive spires shot on the Dream Quest stage. “Michael wanted the POV look to highlight earth, so we made sure lights hit the planet on the bright spot, as well as adding 3-D shadows,” recalled Cinesite visual effects supervisor Carlos Arguello. “To further highlight earth, we digitally toned down the color of the spire elements to silhouettes, adding small glints or highlights, while making other things darker.”

The doomsday squad finally drills and inserts its nuclear device, only to discover that debris storm damage has made it impossible to detonate the bomb via remote control. Someone must stay behind to press the trigger manually. A.J. draws the short straw; but at the last moment, having escorted him down to the surface prior to liftoff, Harry shoves his startled protégé into the Freedom and takes the detonator himself. “He gives his life to save the world,” Michael Bay commented, “so it’s a heroic death. It’s also one of the twists in the movie. Killing off the hero is unheard of in the usual popcorn action film.”

Dream Quest which had conjured up the asteroid, also had the honor of destroying it. The shots were designed to literally blow audiences away, with the detonation first observed from a mile high, the concussive blast then sending the camera eye out into space to witness the chain reaction release of energy that finally splits the Texas-size rock in two.

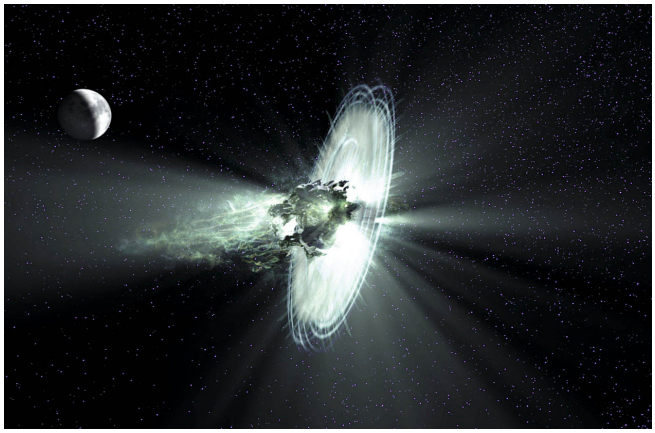
The initial shot featured an in-camera landscape sculpted with bizarre rock formations lining a long crevasse. John Stirber executed some sixty pyro events, timed to rapidly rip along the crevasse toward camera. The explosive energy release was depicted using greenscreen geyser elements shot

by Stutsman and Richard Helmer. “We made a library of these elements that open up the crevasse,” Hoover explained, “which we shot outside at Dream Quest with air mortars blasting ice, glass beads, sand, fuller’s earth and rock salt anywhere from fifteen to sixty feet into the air. We filmed each geyser from different camera angles at about 350 frames per second. Then we tracked the geyser elements into the model, layered and colored them, and also added 3-D rock debris. The production skip-printed it to make it even faster, as if we’re blasting off the surface.”

The shot from space, with both the asteroid’s curvature and the endangered earth visible, used Dream Quest’s twenty-five-foot hero asteroid augmented by fifty geyser elements, interactive light passes, and CG debris tracked and layered in. Dream Quest also comped in its starfield, *Hookah* gases undulating over the exploding surface, and a texture-mapped earth.

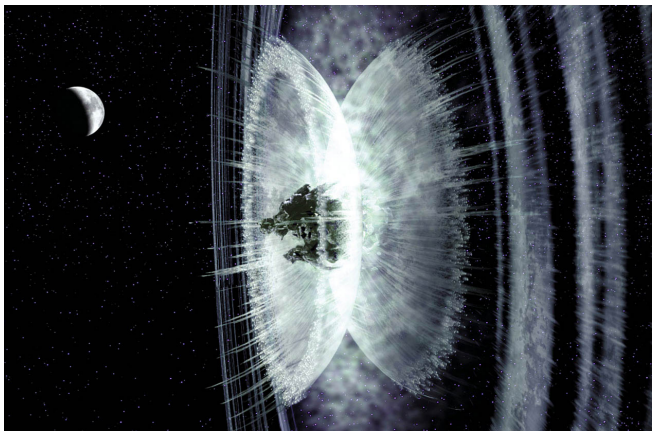
The final explosion shot was all-digital, with Bruce Wright and Rob Dressel creating a CG asteroid splitting apart. “As the asteroid splits, shock rings appear that blow away all the *Hookah* gases,” observed Hoover. “We didn’t want our shockwave to have the standard look of a wave moving out like a growing sphere. We were grasping for something different when Bruce Wright found a Hubble image of a supernova explosion that had made two mushroom balls of gas and light on either side of where the star was coming apart. Bruce used that idea for a digital shockwave with two concave shapes moving away from each other. *Rob* then contributed a *Hookah* shockwave disk that backdrafts and sucks back in on itself.”

The cleaving of the asteroid into two massive fragments required the literal destruction of Dream Quest’s model. After finding a natural seam, the crew wielded chain saws to split the massive model in half. The raw exposed foam was then detailed with plaster and backlit to provide a frenetic texture of moving light. Each section was mounted on a model-mover and shot separately, one heading into the sun, the other tumbling past earth. Dream Quest art director Michael Meaker detailed the globe in Photoshop, adding in cloud formations and the North America coastlines lit up by its seaboard cities.



Its mission accomplished, the surviving shuttle blasts off as the lead oil driller, in a heroic gesture, remains behind to manually detonate the bomb. The subsequent nuclear explosion achieves its objective, rending the asteroid in two and blasting waves of energy deep into space. A final view of the disintegrating asteroid, with earth visible in the distance, was accomplished at Dream Quest as an all-digital effect.

The triumphant return of the Freedom shuttle was topped off with a final location flourish. Shot at the Kennedy space shuttle runway was a dramatic flyover salute from the *Air Force*'s Thunderbird precision flying team. "Five jets came out of the sky, did a low pass over our set, and popped the smoke as they flew," recalled Jim Van Wyck. "I got goose bumps watching the Thunderbirds. For me, that epitomized the level of cooperation we got from the *Air Force* and NASA on this picture."



Shockwaves emanating from the blast were depicted as concave shapes moving away from each other–a concept modeled on a Hubble telescope image of an actual supernova explosion.

Despite an expanding toolbox that allowed the production to seamlessly integrate live-action, special effects and computer graphics, *Armageddon* was essentially an old-fashioned odyssey in filmmaking, a journey from the soundstages of Burbank to oil rigs in the Gulf of Mexico to the NASA launch facility in Florida. It was a journey into the heart as well, with cast and crew enjoying the once-in-a-lifetime opportunity to walk the walk of real space voyagers. For all, the most poignant stop along the way was the remote site at the Kennedy Space Center where Apollo 1 was gutted on its launch pad by a capsule fire, immolating its astronaut crew. The site, which has been left to decay and is being reclaimed by the jungle, was a dramatic backdrop for Harry Stamper's farewell to Grace before his fateful mission launch. Little was done to prepare the grounds for filming, with the crew hosing down the area and putting up a prop plaque commemorating the astronauts who died at the spot. "We were instructed that the site is sacred," Greg Callas recalled. "It's totally removed from the other facilities. It was strange to see–deteriorating and almost looking like Stonehenge, with these big concrete columns and a round steel ring that's all rusted with vines growing on it."

While *Armageddon* raised the specter of cosmic disaster–during its production the Harvard-Smithsonian Center for Astro physics announced the possibility of an asteroid impact in the year 2028, a projection subsequently hailed as a false alarm–the movie was ultimately about the journey into space. And for Michael Bay, whose dreams of space began with his youthful *Super 8* movie, *Armageddon* was a celebration of the power and glory of space flight. "I grew up watching the moon landings on television," Bay reflected. "But ever since the Challenger blew up, the space program has lost some of its luster. For *Armageddon*, I tried to bring back astronauts as heroes."

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A SMALL SOLDIERS STORY

image

ARTICLE BY
JODY DUNCAN

Theatrical wisdom has it that there are no small roles, only small actors. That is unquestionably the case in *Small Soldiers*, a summer release from DreamWorks and Universal Pictures featuring not only actors Kirsten Dunst, Gregory Smith, Jay Mohr and the late Phil Hartman, but also twelve-inch-tall action figures that, empowered by a military 'smart chip,' escape off the shelves of toy stores to wage war on one another.

The film would include kids, animals, puppets and CG characters, any one of which has been known to test the patience of the most even-tempered moviemaker–yet the production ran like a well-oiled machine, in part because visual effects teams on the show were as experienced in their respective arts as any on the planet. Visual effects supervisor Stefen Fangmeier and the Academy Award-winning crew at Industrial Light & Magic were more than prepared to realize the project's slate of two hundred 3-D shots, having been involved in some of the most ambitious computer generated effects films of the past decade. Likewise, Stan Winston Studio, chosen to design and realize the miniscule action figures in the form of remote-control, cable and rod puppets, had created a host of memorable animatronic characters for feature films, earning multiple Academy Awards in the process.

But much of the credit had to go to director Joe Dante, an unflappable filmmaker who had navigated through the visual effects challenges of movies such as *Twilight Zone*: The Movie and *Innerspace* and had orchestrated cunning creature performances with *Gremlins* and *Gremlins 2*. Despite all that effects experience, however, *Small Soldiers* would represent Dante's debut as director of a computer graphics extravaganza. "I had done a commercial with CGI at ILM back in 1990," said Dante, "just to get an idea of what the technology was about–it was primitive then, but still promising–and that was the extent of my computer graphics experience before this film."

It was, in part, the story's considerable digital requirements that had given Dante pause when he first read an original script for *Small Soldiers* nearly five years earlier. His concerns centered not on his own lack of CG experience, but on whether or not the discipline had yet evolved to a point that it could create satisfactory toy characters. "I didn't feel the technology existed to make the picture correctly at the time. In fact, I don't think this picture would have been possible even two years ago. But when I started to see some of ILM's tests, I realized the time had come to make this picture. I still had concerns about the fact that the CGI characters and the puppets were going to have to be blended seamlessly–and I wasn't sure if that was possible. Were the characters going to look the same? Would it be obvious that we were going from one technique to another? But as it turned out,

one of the most satisfying things about the movie for me is that it is difficult to tell which technique is being used in many of the shots."

The small soldiers of the title refer to high-tech, interactive action figures, the *Commandos*, which are programmed to destroy the monstrous, yet noble Gorgonites. Armed with more than just steely eyes, chiseled jaws and plastic guns, the *Commandos* have been equipped with the latest in military technological programming and a computer chip that enables them to learn, making them a threat not only to the Gorgonites, but to the suburban dwellers of Winslow Corners.

With such a premise, *Small Soldiers*, even more than most kid-oriented summer releases, was a toy marketing blitz waiting to happen. Long before a script was finalized, a deal was struck with Hasbro, which would mass produce and distribute a *Small Soldiers* toy line. The timing of the deal dictated the scheduling of the film, leaving Dante and producers Michael Finnell and Colin Wilson with only the summer and early fall in which to prepare what promised to be a tremendous undertaking, especially in terms of the effects. "We were reworking the script while planning the storyboards and designing the characters," Dante remarked, "which was a really inefficient process. A lot of storyboarded sequences never made it into the movie; and sequences that did get into the movie never got storyboarded. *Small Soldiers* was probably the first improv big-budget effects picture."

The time crunch was especially intense for Winston and his team, charged with designing the *Commando* and Gorgonite toy characters, then translating those designs into a variety of multifunction puppets that would be employed extensively on set. "There was such a limitation in terms of time," admitted Winston, "my first thought was, 'How are we going to do this?' There were not only a lot of characters, they were principal characters. We needed time to design them, time to figure out how they would work, time to figure out how to build extremely small mechanisms. At first glance, the time crunch made the job seem impossible. But my next thought was, 'Well, it's got to be done, so we're going to do it.' It's amazing what you can do when you don't have any other choice."

Even as the Winston Studio artists sat down to begin drawing character concepts, they grappled with a critical philosophical issue: to what degree should these characters be designed as toys, and to what degree should they be designed as live characters? "On the one hand," commented Winston effects supervisor John Rosengrant, "we wanted them to be so great that as soon as you saw them you'd think: 'Wow! I want one of those!' But on the other hand, they couldn't be so spectacular that they no longer looked like toys. How were we going to incorporate enough personality in these things–especially the ultra-straight, militaristic *Commandos*–to carry the movie? There was always that restriction–and I think, in the beginning, Stan had some concerns about that."

"When we started playing with off-the-shelf toys to determine how we would build these characters," Winston admitted, "I had concerns that there would be inherent limitations in the range of motion in a toy. We had to decide if we were going to design within those limitations or beyond those limitations. Finally, we decided that we wanted these action figures to have a greater range of motion than what you'd see in a real toy, with more joint movement. The rationale was that these were not just toys, but rather toys that had somehow come alive. More than anything else, I wanted these things to be the coolest toys anyone had ever seen."

In May 1997, slightly more than five months prior to the start of principal photography, eleven artists at Stan Winston Studio began designing the toys, either in sketch or sculpted form. Joe Dante had not yet come onto the project, so they relied primarily on input from Winston and executive producer Steven Spielberg. "Steven and Stan would go through the drawings," recalled Rosengrant, "saying, 'I like this one; I like the direction that one is taking,' and so on. Then we refined the drawings from there. Each artist would take a character and carry it through from the drawing stage to sculpting stage and finally to painting. The *Commandos* were particularly fun for me since one of my hobbies is sculpting miniature military figures. I had a blast designing and sculpting and painting these things; and I think my experience with military miniatures really helped us on this show."

In Small Soldiers, young Alan Abernathy (Gregory Smith) discovers there is more than meets the eye in his collection of fanciful toy action figures–equipped by their manufacturer with sophisticated computer technology that brings them to life with a vengeance. The colorful contingent of interactive toys was realized through a seamless blend of live-action puppets designed and built by Stan Winston Studio and 3-D computer animation by Industrial Light & Magic.

A total of fourteen characters had to be designed–six *Commandos*, seven Gorgonites and the Gwendy fashion doll. Each Commando had a specialty, and had to be conceived in a way that would reflect that character's function in the *Commando Elite*. "Chip Hazard is the overall leader," explained Rosengrant. "Link Static is the communications expert; Nick Nitro is the explosives expert; Brick Bazooka handles artillery; Kip Killagin is the reconnaissance guy; and Butch Meathook is a muscle-bound grunt." The seven Gorgonites were Archer, the dignified, leonine leader; Slamfist, a big, somewhat dimwitted character with a boulder for a hand; the tank-like Punch-It; the hyper- kinetic head-and-legs Scratch-It; one-eyed, tri-legged Ocula; and the spinning, sharp-toothed Insaniac. "And finally there is Freakenstein, who was originally a toy called *Troglokhan*, a barbarian. But he gets left behind and the *Commandos* tear him apart. The Gorgonites put him back together the best they can; but they don't do a great job of it, so he's a real mess, with all of his parts out of place."

Director Joe Dante, with Winston at his studio, reviews an assortment of conceptual illustrations for the repulsive-looking, but peaceful Gorgonites, who come under attack from elite military Commando toys programmed to destroy them. Winston and his crew were given wide creative latitude in devising the look of all the toy characters. Designs were subsequently translated into more than two hundred puppets operated variously by rods, cables and radio control.

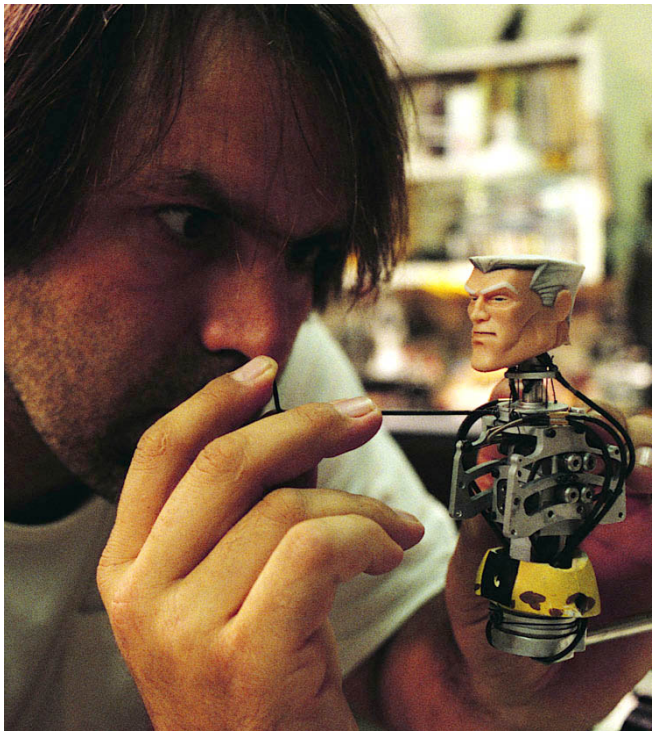
At the time the design process began, the script was still in rough form, and so neither the *Commando* nor the Gorgonite characters had been specifically fleshed out or defined. As a result, the Winston artists had a certain degree of freedom in creating the characters for the film. "When I first

read the script," observed Winston, "the Gorgonites seemed to lend themselves to some really creative designs, much more so than the *Commandos*, which at first just seemed like G.I. Joes. But as we got into it, we became very creative with the *Commandos*, as well; and we ended up with some wonderful characters that were every bit as interesting as the Gorgonites. For a bunch of kids in men's bodies–which we all are at this studio–it was a real kick to come up with this line of toys."

Previously, when designing characters, the artists at Stan Winston Studio had been concerned only with satisfying themselves and the filmmakers who had hired them. But the designs for *Small Soldiers* ultimately would have to please the toughest taskmasters of all–children. To come up with characters that would suit the film and appeal to the marketplace, the studio worked closely with toy designers from Hasbro throughout the conceptual phase. "We all felt that it was very important to have a good line of communication between our designers and the toy company," explained Winston. "For one thing, we were designing toys and we wanted them to be as legitimate as possible–even though they also had to be new, special and beyond anything anybody had ever seen. It was important to work closely with the toy company in terms of designing joints and points of motion that they would normally put into a high-level toy. They came up with some wonderful designs and concepts that paralleled what we were doing at the studio. The face of Chip, for example, was taken almost entirely from the Hasbro designers. We made subtle refinements, but it is essentially what we got from Hasbro. Hasbro also provided the springboard for the look of Archer. Even though the characters were our designs, Hasbro definitely had a big influence on them."

Led by the steely-eyed, square-jawed Chip Hazard, the bellicose Commando Elite strike a macho pose before setting out in search of their Gorgonite enemies.

Winston effects supervisor John Rosengrant sculpts a model of reconnaissance expert Kip Killagin, one of six custom-built Commandos.



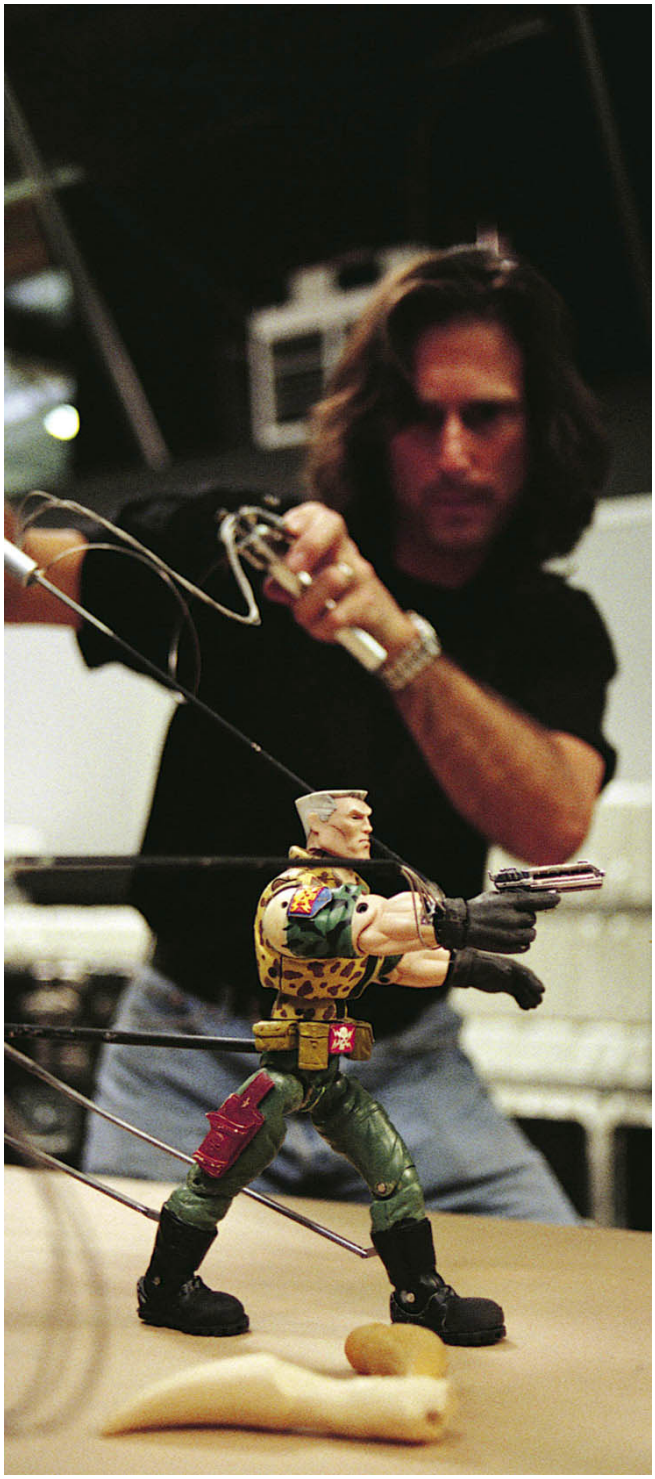
Rich Haugen assembles the mechanical understructure of a cable-operated Chip. Following an intensive period of prototype testing, the Winston crew devised sophisticated rod puppets for each and every character, later adding cable- and battery-operated versions to their arsenal.

Replicating the simple but sturdy look of mass-produced toys, key artist Mark Jurinko applies paint detailing to a model of explosives expert Nick Nitro.

Maquettes were completed by the end of June, and with approvals secured by late July, the Winston team began building its cast of characters. The task ahead was a tremendous one, both in terms of size and complexity. Since each of the thirteen main characters would require multiple versions, the team was faced with creating more than two hundred puppets in just four months–a hundred of which had to be completed in only nine weeks in order to meet production deadlines. Even more daunting was the fact that each of those puppets would be controlled by tiny, watch-size mechanisms, designed and machined from scratch. For a company that had cut its teeth on full-size animatronics for the two *Terminator* films, and then had secured its reputation with projects such as *Jurassic Park* and *The Lost World*–both of which featured huge mechanical creatures–the diminutive toy characters in *Small Soldiers* represented a whole new set of mechanical challenges. "We went from *The Lost World*, which needed giant molds and giant hydraulics, to these tiny precision toys," observed Rosengrant. "In one sense, smaller was easier because we could put all our puppets in a suitcase and carry them under our arms to the set. But what made it hard was getting stuff that small to move right, especially in the limited time frame we were facing. Fortunately, we'd had some practice building small-scale creatures with the compys for *The Lost World*. Those got us thinking in the direction of tiny mechanics and fine, small servos. We followed up with *Mouse Hunt* and *Paulie*, which also required small puppets. It was fortunate that we'd worked on those films and acquired some experience with small characters by the time *Small Soldiers* came along."

Radio controls on a self-contained Nick Nitro are tested by mechanical designer Ewald Schuster.

Since, originally, the filmmakers had planned to accomplish the majority of their live-action toy shots using rod puppets, the Winston crew concentrated on devising a rod puppet for every character during the initial build. "The idea was that there would be a lot of motion control and bluescreen in postproduction," stated effects supervisor J. Alan Scott, who would oversee all the mechanical aspects of the project while Rosengrant concentrated on artistic and production concerns. "The filmmakers thought they would shoot clean plates on the set; then we would articulate these rod puppets in front of a bluescreen, and those shots would all become composites. So producing rod puppets was our main thrust during the first seven to ten weeks of our production schedule."



A coordinated effort by as many as five operators was needed to articulate each rod puppet. John Rosengrant maneuvers an arm on one of the Chip Hazard toys during extensive practice sessions held by the puppeteering team at the Stan Winston shop, prior to the live-action shoot.

As a means of designing mechanisms and working out specific mechanical problems, the studio spent thirteen weeks of its preproduction period doing proof-of-concept tests, primarily with a twelve-inch Chip Hazard rod puppet developed by Scott and mechanical designer Rich Haugen. “We spent eight weeks just developing the first Chip rod puppet,” noted Scott, “while the artists were still doing designs for the other characters. Even the Chip design was a prototype, because we didn’t have time to wait until the character was finalized before we went ahead and did our testing.” A double-size Chip prototype was also built to help the mechanical engineers visualize how various mechanisms would work and fit together. The oversize prototype was created by scanning in the twelve-inch version, enlarging it in the computer, then using those files to fabricate double-sized pieces. “Al Sousa, Kirk Skodis and Dave Covarrubias took what Rich and I were doing on the small-scale Chip and scaled it up to a Chip that was two feet tall. That helped a lot because we were all getting headaches trying to figure out how to deal with such tiny mechanisms. Some of these things were so small, it was hard to even visualize them. The catch-phrase during the mechanical design phase was, ‘Let’s see it in giant view,’ and we’d draw it really big. Since the actual part was only going to be a fraction of an inch big, it was really hard to conceptualize how it would work and integrate with all of these other tiny mechanisms. Sometimes, fifteen-thousandths of an inch made a world of difference in terms of the movement we got out of a mechanism.” After the Chip proof-of-concept tests had been completed, production asked for similar tests with Archer, the Gorgonite leader. “In the next five weeks, we built an Archer from scratch, applying what we had learned on the Chip prototype and developing it even further.”

Winston puppeteers rehearse a double-size rod-puppet prototype of Chip, built during the mechanical design phase of production. A harness worn by one of the crew holds the center rod controlling the character’s gross body moves, while additional rods control arm and leg movements.

During a test shoot on the set, Chris Swift, Alan Scott, Al Sousa and Rich Haugen maneuver a rod puppet of Archer, leader of the Gorgonites. While special rigs helped position the team on set, problems associated with framing so many puppeteers out of the shots eventually prompted filmmakers to abandon the rod puppet approach in favor of more user-friendly, self-contained puppets, which could be remote-controlled.

Winston had challenged his team to come up with rod puppets that surpassed what had been achieved previously with the technique. The mandate was minimal controls and minimal operators on rod puppets that could walk and even run realistically. Five weeks were spent testing and developing rod puppet techniques that would meet those demands. “First,” said Scott, “we made just the lower bodies so we could perfect how these things would move in the hips, knees, ankles

and toes, with just one operator. One performer would give us all the body movement of the character from the waist down. Then, once we had that down, we went on to figuring out how we could control the upper body–the torso, head and arm movements." The arms, like the legs, were rod-puppeted, while the torso, head and facial movements were servo-controlled.

Encouraged by the prototype tests, the Winston team members began building in earnest, devising the most expedient construction approach possible to accommodate the short production schedule. "We went back to the old Henry Ford way of doing things," observed Scott, "developing an assembly-line approach, which we could do since the puppets were so similar in size. We took everything we had learned and developed on the prototypes and figured out how we could make one type of mechanism work for as many puppets as possible. Each of the characters had to be custom-built because they were all so different–especially the Gorgonites–but we tried to streamline things by finding the common threads in technique and procedure when it came to building them." The mechanical engineering of the puppets was also expedited by the use of the computer. A scan of the Chip prototype provided the engineers with files from which they could work out tolerances, resolutions and other mechanical riddles virtually, before building the physical devices.

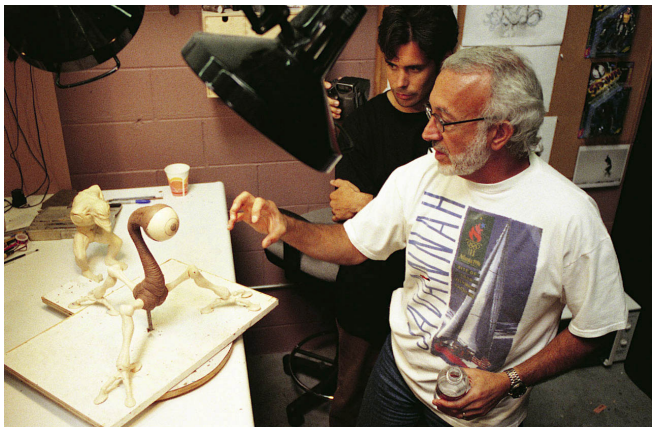
Puppet bodies were made from polyurethane, while heads were cast in soft, flexible silicone that would facilitate mobile facial expression. "Overall," said Rosengrant, "the puppets had to have a toylike sheen to them, yet be more flexible than the typical vinyl toy." Another consideration when choosing materials was making the surface finishes as tough as possible so that they could withstand the rigors of a five-month shoot. The Winston crew experimented with a number of automotive sealers, paints and urethanes to come up with a finish that was extraordinarily durable. Paint schemes, for the *Commandos* in particular, were kept relatively simple to replicate the lack of aesthetic detail in mass-produced toys. "They were still more elaborate than any toy I've ever seen on the market, but the paint schemes retained a toylike quality."

The fabrication process involved making molds from final sculptures, running urethane and silicone pieces, then cutting out the joints and integrating the mechanical parts. "At that point," explained Scott, "the designers would go back and refine the sculpture to include our mechanical joints. Then the mold department, led by Tony McCray, would mold it again to create hero parts. So now we had a sculpture with metal joints in it; and all of those mechanical parts functioned. From there we could mold each individual part–the shins, the ankles, the thighs, et cetera. Each character wound up having thirty-some molds. Once it was molded we could slush in urethane to get a nice thin urethane skin. That gave us a hollow plastic part that we could put over our mechanisms."

Though simple actions could be performed with only a couple of puppeteers at the controls, often as many as five puppeteers were necessary to manipulate the puppets–each of which had three-foot-long rods extending out of the elbows, wrists, heels and the center of the body. "There was one puppeteer on each arm," Rosengrant elaborated. "Another wore a harness that also held the center body rod to control the basic body language. That same puppeteer had rods in each hand that connected to the legs and feet for walking. Another guy worked the head movement with a radio controller, while a separate controller operated eye blinks and jaw sync. To get a nice positive response on these little characters, the rods could only be a couple of feet long, maximum–which made it a little tricky to get the puppeteers out of frame." Ultimately, the restrictions of shooting the characters with up to five puppeteers in close proximity to the puppets made the rod technique an

inconvenient one to use on the set, since each shot would have required major rod and 'puppeteer' removal in postproduction. "There were cases where they were able to frame a shot in such a way that we could hide the rods–shots of a character peering around a corner, for example, or taking a step. But it became pretty complicated to hide all those puppeteers and all those rods."

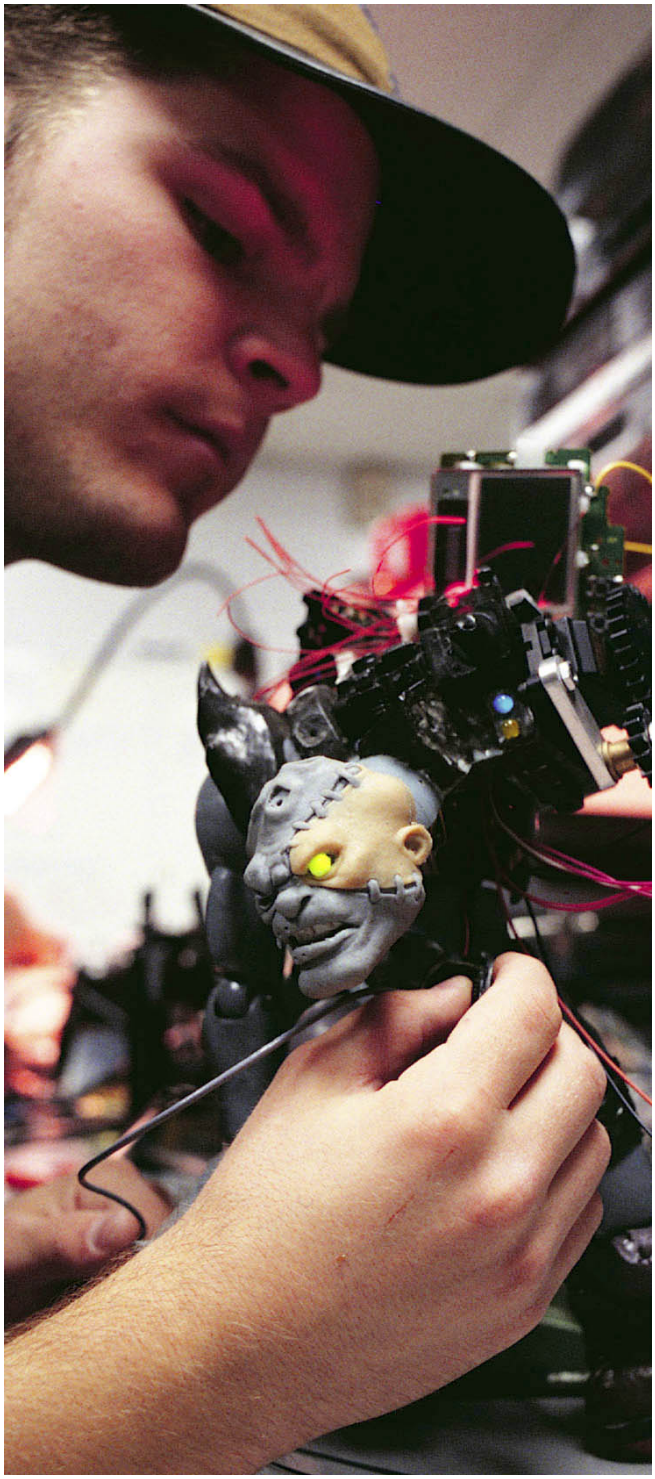
Winston character designer Joey Orosco attends to final paint and finish work on a completed Archer puppet. Special durable finishes were applied to the assembled puppets to ensure that they would withstand the rigors of the five-month shoot.



Stan Winston and Chris Swift discuss sculptural details on a model of the tri-legged Ocula, one of seven Gorgonites whose monstrously comical looks belie their essentially noble character.

"When you've got three or so puppeteers in a shot," affirmed Scott, "there's just no way to film or light rod puppet characters easily. The only thing we could have done was use motion control for rig and rod removal, and no director wants to do that. It's too limiting. So the final film featured a smaller number of rod puppet shots than what they had intended at the beginning." Even the planned bluescreen shoot–which would have solved the problem of hiding or painting out a puppeteering crew–fell by the wayside, as Dante came to prefer the in-camera, live-action approach. "We didn't do any bluescreen postproduction work with rod puppets at all. They eventually realized that it would be best if they could get as much as possible on the set with the actors, and with minimal rod removal after the fact."

The alternative to the rod puppets became battery-operated, self-contained puppets, built under the direction of Paul Mejias–with mechanics engineered by Ewald Schuster and electronics by Kurt Herbel. The self-contained puppets, devised for each character, provided less movement and expression than the rod versions, but had the advantage of being remotely operable, alleviating the problem of framing out a close-range team of puppeteers. The puppets also had no umbilicals of any kind that might restrict framing or lighting setups. "These puppets could be set on a tabletop, turned on and be ready to shoot," Scott remarked. "We had done a self-contained puppet for the baby T-rex in *The Lost World*, and that had been very successful. The actors were able to pick it up and carry it, without any kind of umbilical or external control coming out of it. So the goal was to do the same thing for these characters. Unfortunately, it's a different prospect to do something like that on a character like the T-rex–which was six feet long–than it is on something that's only twelve inches tall."



Electronics team member Glen Derry checks out the articulation on a remote-controlled version of the pieced-together Freakenstein–a victim of shoddy reconstruction by his Gorgonite compatriots following a violent run-in with the Commandos.

The building of self-contained puppets had actually been planned all along; but with the limited articulation that could be achieved in a battery-operated, self-contained puppet, the animatronic devices had been intended for use only as background characters. "The initial idea," observed Scott,

"was that you'd see them moving in the background, but they wouldn't be featured–featured characters would always be rod or cable puppets. Our goal with the self-contained puppets was to get as much gross body movement out of them as possible, completely internally, without worrying too much about more subtle movement." Film tests of the self-contained puppets were enthusiastically received by Dante and company, all of whom were surprised by the facile range of expression that could be obtained from the 'background' characters. "In fact, they were so pleased, they decided they didn't want to just use them as background. They wanted the actors to be able to pick up the puppets and interact with them–but that would only be possible if they had eye and jaw movement, as well as gross body moves. Our prototype was already packed with mechanisms, and now they were asking for two more moves in these things; so we had to come up with a way to get two more servos in the head. In the end we had seven servos, receivers, batteries, circuit boards and remote on/off switches inside each of these characters. They were packed full." Although they were not mechanized and could not be articulated, the puppet arms and legs were rigged with stop-motion joints so that they could be posed. One to two puppeteers were needed to operate the radio control puppets–one on the head, eyes and jaw, and a second to articulate body movements.

As the characters that would be featured most prominently, Chip, Kip, Butch, Archer, Slamfist and Punch-It required not only rod and self-contained puppets, but more fully articulated cable puppets as well. "Those were deemed hero characters," noted Scott, "so we made all three kinds of puppets for them. The cable puppets were similar in function to the rod puppets, but without the rods. On those puppets, everything was controlled remotely via cables that exited through their legs or other areas; so we could dress out the cables, avoiding the need for a lot of digital cable removal in post." The cables ran out of the puppet and were attached to a rack that had, on average, twenty servos, all of which were actuated via remote control by a team of up to five puppeteers–although four usually sufficed. "The rack of servos was only about three feet away from the puppet, so it would have to be dressed out and hidden as well. We also designed these puppets so we could operate them with hand controllers if we wanted to. One of our initial fears was that the radios and servos would not give us the fluid movement and control that you get with hand controllers–a puppeteer's senses are still the best feedback mechanism in the world. With servos, you are one step away from the puppet, which hurts the interactivity. But they ended up working so well, we never had to use the hand controllers." The cable puppets were split up by character between key members of the Stan Winston team: Rich Haugen and Al Sousa concentrated on the *Commandos*–Chip, Butch and Kip–while Alan Scott oversaw Archer, Bob Mano took charge of Slamfist, and Jon Dawe was responsible for Punch-It.

Each of the main characters also had replacement expression heads that could be popped on and off with ease. "Those heads were built to give the characters much bolder facial features than we could achieve with a single head," noted Scott. "They were specifically designed to look astonished, surprised, angry, alarmed, et cetera. Some of the characters had as many as seven different heads that would go onto any of the puppets. The idea was that the CG guys at ILM would be able to morph to these expression heads." In the end, the production team found little use for the expression heads, since any shot requiring that degree of expression was slated as a CG shot, anyway. "The digital world had a lot more freedom to do that kind of thing than what we could do in the physical world."

In addition to the *Commandos* and Gorgonites, the Winston team designed and built multiple Gwendys–the female fashion dolls conscripted as infantry backup for the *Commandos*. "The *Commandos* cannibalize the Gwendy dolls and put computer chips in them and make them their drones, basically," explained Scott. "Originally, they were all supposed to look essentially the same; but in the course of cannibalizing them and inserting the chips, the soldiers make a bit of a mess of them. There are staples and paper clips and bolts in them because the *Commandos* take whatever household items they can find to turn these plastic dolls into their soldiers."

Initially, the filmmakers had asked for both self-contained and cable-controlled Gwendys, in addition to string-puppet versions that would be attached to the human characters they were supposed to be attacking–much like the compys had been rigged for the attack scenes in *The Lost World*. The Winston team soon ascertained, however, that Gwendy was far too thin a character to accommodate the mechanisms for a self-contained unit. "We wound up just doing cable puppets, which only had head and body moves–no arm moves, because they were so spindly," Scott observed. "We made ten of those cable puppets and five 'attack' puppets, which were attached to a velcro suit on the actor, then string-operated from off-camera to make their arms and legs move." In addition to the fifteen articulated Gwendys, rubber and magnetized stunt versions were made that could be attached to the actors, bringing the grand total of Gwendys to sixty-one. Since they were slated to be shot later in the schedule, construction of the Gwendys commenced after production had begun–an effort undertaken by animatronic designer Matt Heimlich, mechanical designer Christian Colqu houn and other members of the mechanical crew.

When it was done, the Winston studio portion of the *Small Soldiers* effort had required not only a crew of more than fifty artists and technicians, but also some 375 pounds of clay, 400 molds, 3500 feet of electrical wire, 520 electrical connectors, 190 circuit boards and 103 microprocessors. "We built five and a half times as many characters as we created for *The Lost World*," asserted Scott, "and we did it in half the time."

As the artists and engineers at Stan Winston Studio worked to complete their huge assignment in time for the start of principal photography, Industrial Light & Magic was gearing up for the 3-D animation task ahead. Winston maquettes had been turned over to ILM as soon as they were approved so that the digital team could scan them and start work on building computer models. With some thirty different creatures–the original fourteen, plus variations on several characters–and more than one hundred props, *Small Soldiers* would be ILM's largest CG model show ever, requiring the talents of nine modelers working full-time for nine months.

The sheer numbers made the project a labor-intensive one. But what was even more challenging was the degree of detail required, since the CG models would have to match Winston's live-action puppets exactly. "Never before have we had to cut so closely between an on-set puppet and our CG puppets," remarked digital model supervisor Tony Hudson. "We were going from closeups of the Winston puppet to closeups of the CG model in the exact same composition–so they had to match in every way. We'd take a reference shot of the puppet from the set and we'd pose our CG character right next to it to do side-by-side turntable comparisons, making sure they matched as closely as possible."

The model team started with the *Commandos*, whose scenes were slated for the early part of the shoot, making those plates the first to arrive at ILM. All six of the *Commando* models were completed in approximately four and a half months, an efficiency made possible by recent improvements in ILM's modeling technology. Among the new tools was software, developed by Christian Rouet, Jim Hourihan and Zoran Kacic-Alesic from the ILM research and development department, which allowed the digital team to capture perfect scans without occluded surfaces or holes–a common problem within the digital realm. The proprietary software also enabled modelers to eliminate unnecessary detail in the geometry obtained from those scans. "We could bring scan data into the new software package," explained Hudson, "draw a patch here and a patch there, and tell it what the resolution of each patch should be. When you have a nice flat surface, for example, you don't need a lot of points to determine the detail; but you need more points where there are folds and wrinkles and other details. This software allowed us to place points very specifically in the areas we needed them, without a lot of density in areas where we didn't."

Since the model in its entirety represented a huge file, individual pieces–such as the leg or the torso–were put in separate files for the addition of details such as military insignias and buttons, also modeled in ILM's proprietary software. "We couldn't just paint the details because the camera was going to get very, very close to the models," Hudson explained. "We had to model everything." Exceptions were those characters seen only in the background. "We had crowd scenes where there were forty or fifty *Commandos* running around. For those, we created low-rez versions that could be rendered much faster. They had the general silhouettes modeled to look right, but the details were all painted on." The Viewpaint team was comprised of supervisor Susan Ross and painters Bridget Goodman and Scott Bonnenfant.

Chris Swift paints final details onto the whirling-dervish-like Insaniac.

Once all of the details on individual sections were modeled and the pieces reassembled, the models were returned to single files and subsequently studied on a virtual turntable. “We rendered each model from a locked camera position as it spun around in a circle,” said Hudson. “That way, we could check it to make sure all the pieces came together correctly and there were no mistakes. After the model was finaled, we saved it out as a high-rez file.”

Each of the CGcharacters–divided among the crew of nine modelers–took three to six weeks to complete. The exception was Freakenstein, a computer model so complex it took Hudson more than three months to finalize. “Freakenstein was a unique case because he was a combination of an organic creature and a mechanical creature, with all of these interlocking gears,” Hudson explained. “He was at least as complex as the dragon in *Dragonheart*. The other problem was that nothing on this model was square or symmetrical, so we couldn’t do the usual cheat of building only one side of the model, then cloning it for the other side.”

Mechanical team member Laura Stella assembles a patched-together Gwendy fashion doll for scenes in which dozens of Gwendys are reconfigured with combat chips and conscripted by the ever-resourceful Commandos to serve as infantry backup. Too spindly to accommodate internal mechanisms, the Gwendy puppets were articulated via cable controls, allowing for head and torso movement. Other Gwendys fabricated by the Winston crew for a final battle scene included wire-operated attack dolls, designed to adhere to velcroed costumes worn by the actors, plus nonarticulated rubber and magnetized stunt puppets.

To expedite the animation process, finished character models were saved out as low-rez files. “If we didn’t lower the resolution of the models,” remarked Hudson, “the interactive speed in the animation process would be three weeks per frame.” The low-rez models were then turned over to technical animators for chaining. “Once the chaining was done, we took the animation and put it into the high-rez geometry so it could be rendered. We also created whatever enveloping needed to be done–which, on this show, was very little since the characters were so rigid.” Enveloping determines how the surface of the model will behave when the underlying chain moves. In a dinosaur tail, for example, enveloping would determine that when a particular joint in the chain bent upwards, the surrounding surface would flex and stretch. The only enveloping required for the relatively inflexible *Small Soldiers* models was on their hands and feet, since those areas were supposed to be made of soft, posable rubber. Hudson did all of the enveloping himself, using new software that worked within Cari, ILM’s proprietary animation software.

While Cari was employed for facial animation–allowing animators to create expression essentially by doing 3-D morphs from one shape to another–key-frame techniques were used for the overall head and body animation. Earlier, however, a completely different approach to the animation had been considered. Brought on to conduct tests when the project was still in its infancy, ILM visual effects supervisor Dennis Muren and senior animator Dan Taylor had generated interesting animation utilizing a rod puppet input device, much like that used by Tippett Studio for its 3-D animated shots in *Jurassic Park*. In a race to complete a handful of shots for a teaser the studio intended to release at Christmas, the ILM team sought the most expedient way to capture the

animation of these characters; and the hands-on input device, for a time, looked as if it might be an efficient approach.

"The puppet input device seemed appropriate for this show," explained Dan Taylor, "since we were going to be matching rod puppets with CG. The computer animation was going to have that rod puppet quality anyway, so why not start with the rod puppet? Rather than use a stop-motion type puppet with a tightened armature, the thought was that we would rod-puppet a device with really loose joints–which was the same technique the Winston people were going to be using on the set. The main incentive was to get the appropriate look in the animation, and there was hope that this might be the fastest way to do that. Efficiency was a really important issue, just because there were so many shots to do and so little time to do them. So we finished a first test–and Joe Dante loved it. He said: 'Yeah, this is great. Let's do all of it this way.'"

Having taken the puppet approach as far as they could go, the filmmakers turned to Industrial Light & Magic for a virtual solution to aspects of the toy performances that required more extreme movements than could be obtained with just puppets. Presented with their biggest CG model assignment ever, the ILM digital team created some thirty distinct CG characters, along with more than one hundred digital props, many of them built from scratch. Over time, the number of CG shots would nearly double, as ongoing script revisions called for increasingly complex action and multiple-character scenes involving the 3-D animated figures. Alone in a toy shop, a CG Chip Hazard pulls a gun on Archer.

Encouraged by Dante's reaction, Taylor and animators John Zdankiewicz and Tom St. Amand produced shots for the *Small Soldiers* teaser, which had been conceived as a takeoff on the widely distributed *Godzilla* trailer. At the last minute, however, the parodic teaser was pulled–although three of the input device shots were saved and cut into a new trailer. Despite its obvious feasibility, the puppet input device technique was ultimately scrapped in favor of key-frame animation, a decision strongly supported by animation supervisor David Andrews. "Dennis liked the input device because it created a different style for these characters, which we were looking for," stated Andrews, "but after looking at Winston's rod and remote control puppets, I thought we could interpret their style of movement without relying on the input device. It would be clicking a mouse as opposed to manipulating a puppet; but since you still have to go in and massage the animation by clicking the mouse anyway, even after you've manipulated the puppet, it seemed to me that the input device was just adding an extra step. I wanted to avoid that extra step because we had a lot of work to do in very little time."

In the confines of his bedroom, Alan befriends members of the Gorgonite contingent –Slam-Fist, Freakenstein, Archer and Punch-It–all computer generated by the ILM crew.

For the majority of ILM's previous 3-D projects, creating organic animation had been the primary goal. In contrast, the animators would be creating rigid characters for *Small Soldiers*–characters that had to retain a toylike, rather than an organic quality. Restraint and overall adherence to the limited movement of the Winston puppets was one of the most difficult aspects of the animation assignment, especially at the early stages of the project. "I kept telling the ILM people, '*Don*'t make it so fluid, so real,'" recalled Dante. "They were so used to making characters absolutely real; but I knew that wouldn't cut with the puppets. A good deal of the first few weeks' work was spent trying to figure out the kind of movements these characters would have."

"I think it was a challenge for the animators to keep the animation simple," observed Stefen Fangmeier. "At the beginning, there was a tendency to do too much, especially in the facial expressions and lip sync. The puppets couldn't move their lips very much, so we couldn't do that with our CG models, either. Nobody wanted to be restrained by what the puppets could or couldn't do–but, to some extent, we had to be because our characters had to match the on-set characters. So we looked at the way the puppets moved, trying to pin down what that style was, and we wound up with something that was in-between robotic and human animation. We didn't want these guys to look human. We wanted them to look like toys that wanted to be human, but still retained their toy soldier characteristics. And, I think, those inherent limitations are what gave these characters their charm. They had a clunkiness to them that was endearing. That, along with the sense of humor David Andrews brought to the animation, really made them appealing."

The animators soon found a way to recreate the herky-jerky movements of the rod puppets in their animation. But that style had no sooner been established when a slightly different behavioral style was called for. "Later in the shoot," explained Andrews, "the director started using the rod puppets less, and the remote-control puppets more. So we had to switch over to the conventions of the remote-control puppets, which always stood locked from the waist down, doing all of their motion from the waist up. As we went along, even though we tried to stick to those conventions, a little bit of extra life did slip into the animation. We always had to keep the parameters of the puppets in mind; but we took some freedoms with those parameters from time to time, just to add life to the shots."

Not only did the animators have to develop behavior that conformed, overall, to that of the on-set puppets, they also had to create a distinct animation style for each character. "Chip was pretty straight," said Andrews, "without much of a sense of humor —a no-nonsense, 'sarge' kind of guy. Then, underneath Chip were the weirdo clowns that we played for laughs: Brick Bazooka was the funny guy, the comic relief; Link Static had knocking knees and was always running around a little scared; and Butch Meathook was kind of big and dumb, yet feeling and sensitive. Joe Dante wanted as much humor as possible in these characters, to soften the violence in the film." Gags and bits of humorous business were first introduced in animatics, then presented to Dante and Finnell for approval. "Joe and Mike would laugh and say, 'Great.' And most of those bits of business found their way into the movie."

The Gorgonites, too, had distinctive personalities and animation styles. Archer, for example, had to project a strong and noble attitude. "The live-action Archer puppets were often in a hunched-over position," Andrews observed, "so we looked for ways to pull up the head and chest to make him

look more heroic. Scratch-It was basically a frog, jumping around like a bouncing ball. Ocula was definitely the kid of the group, the great big eye who was always having fun." Punch-It, the rhino-like Gorgonite, was the most difficult from an animation point of view. "Punch-It was so severely limited in his anatomy, he had to be kind of lumbering. He couldn't turn his head more than about fifteen degrees either way because he had tusks that would rip into his shoulder blades. Also, the structure of his girdle didn't allow for much lifting of the legs because it was so tight. We animated stylistic, funny things for him to do in order to get around his limited range of movement."

The most cartoon-like of all the Gorgonites was Insaniac, who would spin around rooms like the Tasmanian Devil of the old Warner Brothers cartoons. Requiring the development of a tornado effect, Insaniac presented more of a visual effects problem than a 3-D animation problem. "We wanted Insaniac to spin–with a strobing effect on his body so you saw a double image of him inside the tornado," explained visual effects co-supervisor Ellen Poon. "We created the model in such a way that his head and legs could move independently of his torso. So the legs could do one thing while the body was spinning like crazy; and then the head could pop out as well."

In addition to the *Commandos* and the Gorgonites, the modelers built six versions of the Gwendy doll and more than a hundred props–tools, gadgets and other objects used as weapons by the CG characters. The props assignment–originally dismissed as a relatively simple task–proved so intensive that modelers Paul Theren and Larry Tan worked full-time for nearly nine months building nothing but props for the show.

Before any modeling was done, however, the ILM team had to determine exactly what kinds of props might be used by the small soldiers, especially since they would have at their disposal only those items that could be found in a typical suburban household. "The script hadn't specified what these props were," recollected CG supervisor Erik Mattson. "Joe Dante just said, 'Come up with whatever looks good.' So we sat around a table one day and talked about what household items or tools these characters might find in a kitchen or garage that they could use as weapons. We made a list of props that we thought were suitable–anything small and sharp, such as drill bits, Cuisinart blades, razors, ice picks and garden implements–and then began modeling them." Rather than scanning practical versions of the various tools, most of the CG props were built from scratch. "We've built similar props for past movies, so we were able to reuse some of those. But we also built quite a number of new props."

Most of the prop weapons were metallic by nature, presenting ILM with one of its trickiest problems to solve. Though the digital department had, years earlier, created the chrome-like T-1000 character for *Terminator 2*, the smaller-scaled props were more difficult to render realistically. "I worked on *Terminator 2*," said Fangmeier, "which had the ultimate chrome object. But that guy was highly reflective, which was much easier than making these little props and integrating them into almost every shot. With the liquid metal T-1000, it was more a matter of reflecting the environment than creating the look of chrome. We could basically make it a mirror, which is easy to do in CG. But a metallic object in real life doesn't act like a perfect mirror–there's a lot of break-up and diffusion of the reflection. Just to get these metal objects to look right from shot to shot was a big deal."

Ultimately, the props were given an appropriately metallic sheen through Viewpainting, with specularity maps used to define the reflective areas. "We put a lot of time and effort into messing

these things up so that they wouldn't look too shiny and perfectly metallic," remarked sequence supervisor Michael Di Como. "It was mainly a matter of putting some nuance in it to dirty it up. But, unfortunately, it was something that had to be redefined for each shot. We'd get one shot looking just the way Stefen wanted it; but when we tried to plug in that same thing for the next shot, it wouldn't look right. The camera position, the lighting, the reflections might be just slightly different, and suddenly the whole shot had to be tweaked."

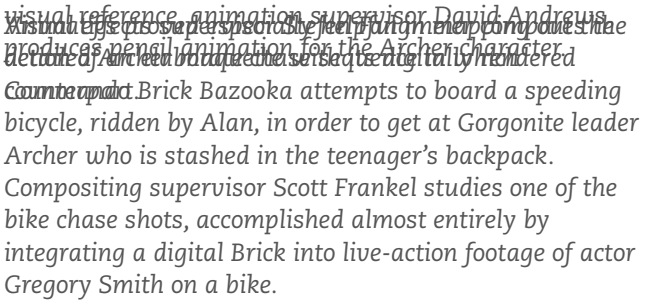
ILM was still building models and grappling with animation issues when filming got underway on October 31, 1997. Both the ILM and Winston teams were on the set nearly every day of the five-month shoot–a shoot that would remain surprisingly free of the frustrating delays so often associated with puppets. "At the beginning," recalled visual effects coordinator Leslie Barnett, who worked from the production end to synchronize both the puppet and the digital components of *Small Soldiers*, "Stan Winston promised, 'You'll never have to wait for us.' We all laughed, and said, 'Yeah, right.' In fact, Paul Deason, our co-producer, wrote that down on a piece of paper and stuck it on his wall as a joke. But as it turned out, we never did have to wait. It was remarkable; and I think it had to do with the professionalism of the puppeteers, more than anything. They knew what they needed to do and they got the job done."

The Winston team's efficiency on the set was due in part to a rigorous six-week rehearsal period prior to shooting, during which the puppeteers had rehearsed a minimum of two hours per day. "Because it would take four to five puppeteers to bring some of these puppets to life," observed John Rosengrant, "we really had to jell as a team. We had to not only learn the technicalities of working the controls, but also search out a performance to convey the action and emotion."

On-set success was also ensured by the durability and reliability of the puppets. "They didn't break down very often," said Dante, "especially in comparison to my previous experience with puppets. These were complex little machines, and yet they seldom broke down. And when there was a little shake or something else went wrong, it took

Pencil animatics, devised for nearly every CG shot in the film and matted onto live-action backgrounds, allowed ILM animators to previsualize complicated action scenes prior to working in 3-D. Using a Winston maquette as

very little down time to fix it. I had expected a lot of tragedy in dealing with the puppets–but there was very little. It was extremely efficient."



visual reference, animation supervisor David Andreus produces pencil animation for the Archer character. Animation supervisor Jeff Fowler composites the actor's live-action performance into the sequence digitally. Command Brick Bazooka attempts to board a speeding bicycle, ridden by Alan, in order to get at Gorgonite leader Archer who is stashed in the teenager's backpack. Compositing supervisor Scott Frankel studies one of the bike chase shots, accomplished almost entirely by integrating a digital Brick into live-action footage of actor Gregory Smith on a bike.

"We tried to design the puppets so that repair and upkeep on the set would be quick and easy," confirmed Alan Scott. "The mechanisms were very accessible. We could pop off the torso, the chest, et cetera, and just strip it down to the bare mechanism so that we could work on it in a matter of minutes. Because the mechanisms were small and delicate, we'd predicted a lot of breakage, just from interaction with the actors and with the environment. But, fortunately, breakage was kept to a minimum. During our prototype phase, we'd redesigned things to eliminate fatigue on the cables and pulleys; so they wore amazingly well. Ninety percent of the cables never broke."

Despite the ingenuity of the puppet controls and mechanisms, the on-set performances were still dictated by the physical limitations of twelve-inch-tall characters articulated via servos and cables. Spielberg, for one, had preferred the somewhat rigid, toylike quality of the movement, and had encouraged the Winston team to incorporate that rigidity into the puppet performances. But once on the set, filmmakers began to favor a more organic performance. "It was something that evolved," recalled Rich Haugen. "In the beginning, these characters were supposed to look like toys, act like toys, move like toys. But as soon as they got the puppets on set, they wanted to see more life in them. More and more, they became twelve-inch people, as opposed to just toys."

"There wasn't time to go back and change the puppets at that point," elaborated Alan Scott, "so then it became a matter of the puppeteers refining their performances to make them more lifelike. Fortunately, we had maximized the puppets mechanically, far beyond anything we had done on *Mouse Hunt* or *Paulie*; so the capability was there to get more control over these small mechanisms. That helped us tremendously when we got on the set and had to push these things farther and farther. Because we had tested them repeatedly and gone through numerous designs, we went to the set with puppets capable of delivering very smooth, controlled performances."

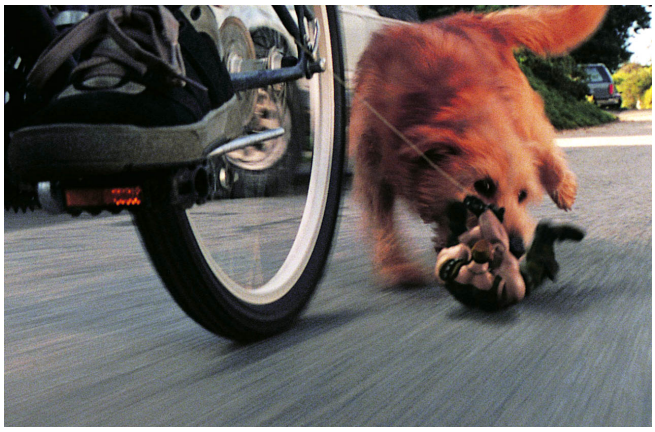
On the set, the puppeteers not only created the toys' physical and behavioral performances, they also delivered the characters' lines of dialogue. Typically, whoever was operating the puppet's eyes and mouth would also take responsibility for line readings, while additional puppeteers controlled the remaining head and body moves. "It was extremely helpful to have the voice in there in dailies," John Rosengrant commented. "We'd hear the characters delivering their lines as they were looking around and moving–it really let us see what we had. And even though our voices were going to be replaced with the actors' voices eventually, we really had to act in these scenes, for the sake of getting our character's attitude and actions right, and for the sake of the other actors in the scene." Throughout filming, Chris Swift would most often provide the voices of Archer and Chip, ultimately replaced by the vocal talents of Tommy Lee Jones and Frank Langella.

In total, it took fourteen to twenty-three puppeteers, thirty-four radio transmitters and seventy-two radio receivers to control the army of small soldiers. Group scenes featuring multiple toy characters were particularly chaotic. "To keep the puppets under individual control required fifty-two unique

radio frequencies," Scott observed."Futaba radio controllers have just eighty frequencies available– so for just this project, we were using sixty-five percent of their available frequencies."

One of the busiest sequences, in terms of sheer numbers of characters, was one in which the *Commandos* commandeer an array of lawn and workshop implements to create a small fleet of makeshift assault vehicles. The self-contained puppets were modified for the scene so that they worked in conjunction with small-scale vehicles constructed by special effects supervisor Ken Pepiot and his crew. "We placed the self-contained puppets in the cars," explained Scott, "loosening up the stop-motion joints in their arms and legs so that they would be free floating. We positioned their arms and hands on the vehicle controllers, then articulated the controllers remotely, so it looked as if the characters were manipulating them. We would remotely move the lever on a car; but with the puppet arm attached to the lever, it looked as if the arm was moving the lever."

Commandos prepare to launch their comrade via a sling-shot contraption made from a bungee cord and rigged to catapult the muscle-bound soldier onto the passing bike.



Having fallen short of his objective, Bazooka is dragged along behind the bicycle, mere inches from the snapping jaws of a neighborhood dog in swift pursuit.

Working independently yet in tandem with the Winston crew throughout principal photography were Stefen Fangmeier, Ellen Poon and other key members of the ILM team. "ILM was on the set much more for this show than they had been for *Jurassic Park* or *The Lost World*," commented Leslie Barnett. "On those shows, there were specific sequences in which dinosaur shots were lumped together; but on this one, the CG characters were featured throughout, so ILM had to be on the set throughout. Either the *Commandos* or the Gorgonites were doing something almost every day of the shoot."

A closeup shot reveals the Commando grabbing ahold of the bicycle wheel frame and pulling himself out of harm's way. Portions of the real bicycle were replaced with digital replicas in order to enhance the interaction between the vehicle and the CG character. Additionally, 2-D compositors had to merge shadows cast by the digital Brick with real shadows contained in the plate photography.

Among the ILM on-set chores was taking vital measurements that would facilitate the tracking and match-move tasks for each CG shot. Just as advances in mechanical engineering had streamlined puppet maintenance and performance issues, the digital skill and experience gained at ILM over the past decade paved the way for an on-set effects presence that was neither intrusive nor time-consuming. "We've become so good at this," noted Fangmeier, "that our measuring doesn't impact on production at all. For any given shot, what we had to do took ten to fifteen minutes, at most. Most of the sets were small and confined, so we were able to use just an old-fashioned measuring tape to get our numbers. Also, since most of the sets were interiors with furniture, there were a lot of square corners and easy-to-define objects to guide us."

ILM was also on the set to ensure that both clean and reference plates–complete with posed puppet–were captured for every planned CG shot. "One of the things I found refreshing on this film," said Poon, "was that the director and the crew let us do reference takes. They'd let us go in with the puppeteers and move the puppet in somewhat the same manner we'd be animating the CG character–pantomiming the basic action. We'd move the puppet through his actions for that shot, so we would know what he was supposed to do. Because we were going to be working on these things so long after the live-action was completed, it would be easy to forget what the director wanted. So we had these reference takes to remind us what the character was supposed to do in each shot–and that really helped. The other thing they let us do was put in a lighting sphere so we could get an idea where the lights were. The director of photography on this film changed the lighting on a per-shot basis, which meant it would be easy for us to lose track of where the lights were on the set. So they let us do reference takes on a per-shot basis. And with shots that had big camera moves, they let us walk the sphere through the scene. On many of the films we've been involved with, the director wouldn't let us get that kind of crucial reference. It took a lot of film and a lot of time–but it made our job so much easier."

The puppet reference also guided the ILM team in determining depth of field for each shot. Director of photography Jamie Anderson would typically light the puppets with scaled-down instruments, creating a very limited depth of field that had to be matched in the 3-D animated characters. “To make it seem as if the camera was scaled down and right at the level of the puppets, they used a narrow lens on the set to shoot them,” explained Michael Di Como. “Chip would point forward, for example, and the focus was so narrow that his hand would be out of focus, while his face and chest were in focus. So we had to use a lot of depth-of-field tricks to match the puppet shots. One of the problems with CG is that models tend to be in focus all the time. To make them match the live-action better, we messed them up a little and pulled things out of focus. We can do special render passes to control the amount of focus on a character in any given shot.”

Clean plates were also shot for sequences utilizing the live-action puppets, as insurance against an unsatisfactory performance. “In general,” stated Fangmeier, “they would try to get the shots with the puppets. But they’d shoot a clean plate for CG, as protection. That way, if Joe Dante didn’t like the action of the puppet, he could make it a CG shot after the fact.”

Unlike previous 3-D assignments–in which physical effects to suggest interaction of the CG character with the environment were crucial to the ultimate success of the animation–*Small Soldiers* required very little in the way of on-set interaction, thanks to the diminutive statures of the main characters. “These characters would not have much impact on their surroundings, in reality,” related Fangmeier. “They weren’t crashing through trees and knocking over houses and stuff like that. What interaction was required, we decided to do mostly in post. For example, if one character was going to jump onto a globe and make it spin, we’d animate that action in post, rather than go to all the time and trouble it would take to make that happen on the set. It was easy enough to reproduce that globe in CG and then animate it exactly the way we wanted it, rather than being tied to a live-action element.”

As early as Christmas, less than two months into filming, the production delivered edited sequences so that ILM could begin its CG work. “We had to get going right away, just because of the schedule,” remarked visual effects producer Kim Bromley. “We had a situation where the movie would finish shooting in March, and had a July 10 release date. So we had to have overlapping production and postproduction schedules, and we had to have a certain number of shots in by Christmas so we could get started. Joe and the production people were very good about cutting sequences right away and giving us what we needed as soon as possible. From Christmas on, it was a steady flow of work. We had about thirty finals by the time filming wrapped in March; and that left about two hundred shots to final in the following three months.”

First on the agenda was the creation of animatics for every CG shot in the film–with the exception of a locked-off scene in which Chip delivers a cliché-ridden Pattonesque speech in front of a flag. The first set of animatics completed was for the most action-heavy segment of the film–a complex sequence in which Brick Bazooka struggles to clamber aboard a speeding bike ridden by Alan Abernathy (Gregory Smith), an unwitting teenager who is carrying Archer, targeted as the enemy by the *Commando Elite*, in his backpack. David Andrews and animators David Byers Brown, Chuck Duke and Scott ‘Huck’ Wirtz divided up the sequence into eight shots apiece, producing animatics and plotting out the sequence in terms of business and composition. “They were pencil drawings that

we then matted onto the live-action background," commented Andrews. "Once Joe approved the animatics and made his comments, Chuck, David, Huck and Michaela Zabranska did all the animation for that sequence. Doing animatics for every CG shot really sped up the process because, once they were approved, the animators could just go and deal with making it work in 3-D space. They already knew what the business was and what the composition was; so they didn't have to deal with those issues once they actually got to doing their animation."

Even though either Fangmeier or Poon had been on the live-action set to en sure the filming of plates that would accom mo date the 3-D animation, with both the first and second units running simultaneously, and with the limited time frame of the shoot, not all of the plate material was ideal, either in terms of lighting or action. "There were problems with some of the background plates," Andrews admitted. "There was a scene in which the camera was supposed to pan up and down while Scratch-It was bouncing on a bed; but there hadn't been anyone on set to rehearse the tempo of that camera move. Without an animator's mind there to direct that camera motion, the action wasn't really timed right and we had to fight to make the character look like he was leading the camera. For most of our shots, however, we had the puppet shots to guide us and to guide the cameraman, who knew from that take what marks he had to hit, et cetera. That was very helpful."

As ILM continued its shot production, Joe Dante's increasing preference for more expression in the characters mandated an adjustment in the animation style. "As time went on, Joe asked us to cheat the performances a bit more," Andrews acknowledged, "so we began to do more in the facial animation, in particular, than we had at the beginning. For example, we had a closeup shot of Chip giving an order in the scene where they are all working in the garage, building their trucks and stuff; and our first go at it was exquisitely puppetlike. But Joe kicked it back to us because it was too puppetlike. That began to happen more and more–and it made sense, even in terms of the story. The toys have this chip that enables them to learn from their experiences; so it would make sense that, as time went on, they would become less toylike and more human. We could get by with cheating the animation a little because these characters looked so perfect. They absolutely looked like toys, and like they were in these environments–so when they came to life, we had some room to maneuver in the animation."

"My feeling was that we didn't need to constantly remind the audience that these characters were toys," Dante explained. "So I thought we might have the toys be a little stiffer in the beginning of the movie, and more fluid at the end–because, by the end, these characters are more real in the audience's mind, anyway. They become more human because they have been watched by an audience that wants them to be real characters. And when we added the actors' voices, that ramped up the reality another notch."

Though, in general, ILM's work became more fluid as time went on, the animators still had to adjust the animation to its specific placement in a scene. "If one of our CG shots ended on a puppet," noted Andrews, "we would have to make the animation slide into the rigidity of the puppet. For example, early on we discovered that as long as Chip made very deliberate staccato moves, we could get by with a lot in between. At the beginnings and endings of shots, the characters would be rigid; but in between, they could be quite nimble. The typical situation was that we would come out of a puppet shot, into full 3-D animation, then back into puppet again."

While Dante provided such guidance throughout the animation process, for the most part the director took a 'hands-off' approach, leaving the ILM team to do what it does best–creating photorealistic computer animated characters. "One of the things I liked about Joe Dante," noted Ellen Poon, "was that he didn't feel the need to go into finite detail with us. Every morning, Stefen, David and I would go over the animation with him and he'd make comments. But after that, we didn't have to send him anything until a shot was finaled. He trusted us to do the lighting, compositing and animation as we saw fit. In other words, he left us alone to do our jobs properly–which is very unusual in this business."

"Given the hectic schedule," Dante commented, "I was only too happy to trust ILM. They do know what they're doing. They knew the established parameters of the characters and of the scenes. Early on, they began adding their own character things–jokes, gags and behavioral things. It was stuff I hadn't even asked for, but certainly appreciated."

CG supervisors Gerald Gutschmidt and Erik Mattson oversaw the process of integrating the final 3-D animation into the live-action plates. "Nothing new had to be developed for this show," explained Gutschmidt, "we just had to make sure the pipeline was in place. The geometries for this show were heavy, so we had to do a lot of streamlining to reduce memory usage and to render the models quickly and efficiently. The fun part was that we could really concentrate on how these things looked, rather than on technical problems, since this show was easier, technically, than some have been."

As always, the first step in marrying the animation to the live-action was to do a match-move on the original plate. "The match-movers digitally recreate the environment," said Mattson. "They recreate ground planes, reference objects, trucks, furniture–whatever the CG characters will interact with or will be used as reference to track the camera motion. Usually, they create this in wire-frame, but they will also render a checkerboard type pattern on top of that to make sure that things are lined up. The match-moves are probably the most critical aspect of what we do–and the match-movers don't get enough credit. Some match-moves were horrendous on this show. The camera was moving as the CG characters were standing still, which is a deadly combination. Any time you have a moving camera there's some shake–it's never perfectly smooth–so it's very hard to go in and match all the little vibrations. Very few CG shots are ever filmed motion control, because directors find it limiting. So we frequently wind up with hand-held camera moves that are all over the place. The people working on the new *Star Wars* are experimenting with a way of digitally recording hand-held camera moves; and if that works, it will help the process tremendously in the future."

Matching the live-action lighting was one of the most difficult aspects of integrating the CG characters into the plates, especially those filmed in second unit, where the lighting was not always appropriate. “We had to match that lighting, even if we didn’t particularly like it,” acknowledged Poon. “The lighting in the first unit shots was also a problem sometimes. Jamie Anderson is a great DP, but he tended to use a lot of different lights and different setups with scrims or flags. So there would be a big difference in the lighting from one scene to the next–in addition to the differences between the first unit and second unit stuff. He also used differently scaled lights for the puppets and the humans. He would put little baby spotlights on a puppet, or even just aim a flashlight on it. So the puppet characters were being lit individually and separately from the rest of the environment. Matching all of that different lighting made our job more difficult.”

Matching a Winston puppet of Butch Meathook, Viewpaint supervisor Susan Roll adds digital paint to the CG version. Frequent and closeup intercutting between the live-action puppets and their virtual counterparts demanded that the puppets be replicated digitally down to the minutest detail.

In most cases, ILM technical directors were able to cheat the lighting to show off their CG characters to better advantage, brightening or coloring the background plates as needed. “We had some freedom when we were lighting our characters,” Mattson commented. “We didn’t have to strictly match the reference shot, because they didn’t necessarily light that plate as they would have if it had been a puppet performance shot. Sometimes a reference shot was quickly thrown together; and no one was worried about that because they knew we’d do something nice with it at our end.”

In a final showdown, the small, yet menacing Commandos advance on the Abernathy home armed with an arsenal of weaponry, as a determined Stuart Abernathy (Kevin Dunn) prepares to defend his family and the Gorgonites against the marauders. The protracted sequence –packed with action, explosions and battling toy figures–would encompass nearly half of all the CG shots featured in the film.

As so often happens, the number of CG shots grew as production continued, in part because the script was being revised throughout principal photography. “*Gremlins* was a very complex movie,” said Dante , “with three months of postproduction shooting without actors, just to do all the puppeteering. But *Small Soldiers* was even more complicated because we had to make split-second decisions on the set as to which things would be done with puppets and which were going to be CGI. And since a lot of our plot developments didn’t get scripted or written down at all, we were forced to make snap decisions throughout production. As a result, ILM was constantly getting new shots that hadn’t been planned–which meant that I had to go through footage previously shot and

try to pull out CGI shots to keep the number down. It wasn't that we couldn't afford new shots–but there was only so much time."

Each revision seemed to demand more action from the small soldiers–action of such complexity it could never be captured with one of the live-action puppets. "I was very impressed with the work that John Rosengrant and the other Winston Studio guys did," noted Kim Bromley. "They got those puppets to do stuff I wouldn't have imagined they could do, and they gave them real personalities. But the more outrageous behaviors could only be accomplished with CG. As a result, our 3-D shot count grew from fewer than 150 to more than 200."

Joining the final fray are the Gwendy dolls, now transmuted into Commando-led grunt forces. Digital modeler Tony Hudson works on geometry for the head of a digital Gwendy, one of six versions fashioned by the ILM team.

Those shots were spread out over more than a dozen scenes, including an early one in a garage. In the sequence, the *Commandos*–who have decided that their plastic toy ordnance is insufficient–rummage for tools that can be used for weapons or modified to make vehicles. More than any other, the 'garage discovery' sequence featured back-to-back, closeup intercutting between digital and live-action puppets. "That happens three times in the sequence," Michael Di Como remarked, "so we had to match our CG models to the puppets especially carefully in that scene."

The retooled Gwendys–surgically implanted with combat computer chips, then pieced back together with staples, paperclips and bolts–advance, zombie-like, on their designated targets. As filmmakers began to favor more realistic character animation during the course of production, the somewhat rigid, staccato animation purposefully employed by the ILM team to match the Winston puppets' toylike moves eventually gave way to a more fluid style that encompassed elements of humanlike expressiveness.

Another key scene takes place in a kitchen, where Nick Nitro is stuffed into a kitchen sink garbage disposal. "You see him spinning around and then he crawls out," explained sequence supervisor David Meny. "We could have done that with the practical disposal; but there was a metal ring around it that would reflect the character, so we decided to replace the real disposal area with a CG element." In that same sequence, Nick lights a match in his mouth–a gag that cut from an all-CG element to a live-action puppet. "There is the CG shot of Nick lighting the match–and even the flame was CG. The TD on that, Felix Balbas, animated the shapes for the flame, did the lighting and then composited it and tweaked it to match the next shot, which was a full puppet with a real live match."

One of the most elaborate sequences of the movie is the bicycle chase, inspired by a gag from *Raiders of the Lost Ark* in which *Indiana Jones* is dragged underneath a truck and then attempts to climb back into it from the outside. In the *Small Soldiers* takeoff of the stunt, Brick Bazooka shoots a

harpoon into the water bottle of the bicycle and gets dragged along, then climbs up on the bike. Throughout, a dog is chasing close behind–a bit of animal wrangling achieved by dragging a lure from the back of the bicycle prior to each take.

With the exception of two side-angle shots that employed a live-action Brick puppet, the entire twenty-five-shot sequence was accomplished by integrating a digital version of Brick into second-unit plates photographed by Stefen Fangmeier. "The major challenges there," explained Fangmeier, "had to do with getting the character to work within the frame, scale-wise. We cheated the size quite a bit in some of those shots by making him a little smaller, just to get the dynamics of the scene to work. It was very difficult to figure out exactly how the action was going to work and what the character would grab onto. We had to stage it and shoot it so that such things as the way in which the pedal swung out or the way Brick was hanging onto the bike would work, animation-wise."

To maximize the illusion of interaction between the bike and the Brick character, portions of the bicycle were replaced with CG. "In some instances we just had articulate mattes made to follow the outlines of the bike where we wanted Brick's hands and feet to be," Erik Mattson commented. "In other cases, we actually built geometry. We could also use that as reference to indicate where we needed mattes and where that geometry could be used as a holdout object."

Integration of the scene was complicated by the fact that the weather conditions had changed considerably over the three-day exterior shoot. "We wound up with some overcast sky in the plates," explained Fangmeier, "which made them very tricky. Getting a CG character to fit into an environment in direct sunlight is ideal because you have a strong light and strong shadows, which are much easier to match as a lighting scenario. Overcast daytime lighting is really the worst because you get very diffused soft shadows. One of the technical limitations in CG is that we use point light sources–which are not what you have in an overcast situation."

Existing ground shadows, cast by the real bicycle, also presented the 2-D compositors with a challenge. "We had to merge the shadows of our characters with the real shadows," noted lead compositor Marshall Krasser. "There were some edge-lines around the shadows that we blended in so you couldn't tell where our rendered shadow started and the real one stopped. Another interesting thing we had to do for that sequence was a shot when the character is straddling the back tire, which had this knobby tread on it. We had to recreate the tread to get that part of the tire to match the rest of the shot."

The battle sequence in the final act of the film–in which the *Commandos* engage Alan and Christy Fimple (Kristen Durst) and their families in an effort to destroy the Gorgonites–constituted about half the total number of CG shots. "Some of the shots in the battle scene were 2¥-D shots as opposed to 3-D," observed Ellen Poon, who supervised the sequence. "There are shots, for example, in which the *Commandos* project these lethal disks or jagged-edged flywheels or nails–things like that. We couldn't do those projectiles on the set for fear that they might really hurt the actors. So we had to put all these projectiles in afterwards. Since they were moving so fast and were kind of a blur, we thought we could get by with 2-D rather than 3-D for some of them."

In the course of the action, Alan attempts to deactivate the *Commandos* by creating a huge electromagnetic field. "The kid goes up the power pole," Poon elaborated, "and there is a big

showdown between Archer and Chip up there. Eventually, Alan manages to blow up a transformer by inducing an overload. When the transformer blows, a big energy ring comes out of it. We designed some artwork to create a wave that spreads out over the entire neighborhood for a wide aerial shot." Half of the backgrounds for the power pole sequence were shot first unit, while the other half were shot second unit. The results were disparate and incompatible plates. "Continuity-wise, they did not match," remarked David Meny, "so Ellen had us spend a lot of time changing the color balance on all the backgrounds, just so they would fit together."

With ILM still finaling shots into June, *Small Soldiers* followed a recent trend in which delivery dates are moving ever closer to release dates. The completed film was not only an entertaining summer offering from DreamWorks, it was another successful collaboration between Industrial Light & Magic and Stan Winston Studio, two companies that have brought their respective and very considerable talents to bear on some of the most grand effects films of the past twenty years. And, as they had before, the two units worked hard to maintain an atmosphere of mutual respect and generous cooperation. "There was no competition between them," Leslie Barnett marveled. "They simply enhanced each other. There was always a good feeling between the two groups on the set, which made everything run so smoothly. I'd always heard, 'Never do a picture with kids, puppets or animals'–and this show had all three. But, somehow, it worked."

It worked, despite the inherent technological difficulties of a film starring twelve-inch-tall action figures, despite an ever-evolving script that made *Small Soldiers*, in Joe Dante's words, 'the world's first improv big effects picture,' and despite the many challenges of marrying two very different disciplines. "In the end, I was pretty happy with the combination of puppetry and CGI," Dante concluded. "There is some extremely expressive puppet work in the movie that was much less expensive to do than if we'd tried to do the whole movie in CGI. And I know that, as far as performances go, the two lead kids in the picture would not have been able to come up with as good a performance if they'd had to play the entire picture to nonexistent characters. So the puppets were very important to the success of this film. Conversely, there are many things in the movie that could never have been done in any way other than CGI. *Small Soldiers* needed both."

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